HUMAN BIOLOGY
a record of research
DECEMBER, 1945
VOL. 17 No. 4

POPULATION GROWTH IN PUERTO RICO AND ITS RELATION TO TIME CHANGES IN VITAL STATISTICS*

BY JOSÉ L. JANER

INTRODUCTION

THE problem of maladjustment of population to resources in the island of Puerto Rico has stimulated, in recent years, many native as well as foreign observers to write on the population problem. An inspection of the extensive bibliography already accumulated, reveals that most of the observers have seen the population of Puerto Rico growing at a pace that suggested that this small island was really going to be an example of the population theories of Robert Malthus. It is interesting, however, to notice that although the island of Puerto Rico can boast of having relatively accurate data on population over a period of one hundred and seventy-five years, none of the students of whom the present writer has knowledge has attempted to describe the population growth of this island quantitatively to see whether it really fits in with the Malthusian theory.

Since Malthus was perhaps the first to handle the problem in a scientific manner, his theories regarding the growth of populations have considerable historical value. However, it has been observed in every

* From the Department of Biostatistics (Paper No. 226), School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Md.

country where population growth has been studied quantitatively, that his postulate of a constant rate of increase does not hold for any long period of time. Instead, the rate of growth decreases steadily with the flow of time, unless the conditions under which the population is growing are seriously altered. The logistic curve which postulates a dampened rate has proved a far more satisfactory description of population growth when tested against actual experience (Pearl, 1).

A quantitative study of population growth on the island of Puerto Rico is needed in order to establish what the pattern has been, what the prospects are for the future and whether this island should be considered an exception to the general experience in human population growth. Any such study leads us naturally to inquire about how the population has been affected by time changes in births, deaths, and migration and to the analysis of successive life tables in order to evaluate the changes in the mortality experience of the community.

The object of the present paper is, therefore, to present a quantitative description of the growth of the population of Puerto Rico and to analyze the dynamics involved as revealed by the island's records of vital statistics. For this purpose, we have found it convenient to divide the paper into two parts:

Part I. Analysis of population growth.

Part II. Time changes in the life tables for Puerto Rico.

PART I. ANALYSIS OF POPULATION GROWTH

During the Spanish regime, ten censuses of the population were taken in Puerto Rico at irregular intervals. The first of these censuses was taken in the year 1765, and the ninth, which was the last officially recorded, in the year 1887. The tenth census was taken in the year 1897, but apparently it was never made the subject of an official publication. In 1898, as a result of the Spanish-American War, the United States took possession of the island. The first census under the United States regime was taken in 1899 by the U. S. War Department. In 1910, the island of Puerto Rico was included in the decennial censuses of the United States, so that, from that date on, Puerto Rico had a census taken regularly at ten-year intervals. An additional census was taken in the year 1935 under the auspices of the Puerto Rico Reconstruction Administration.(2)

The population enumerated in each of the censuses taken from the year 1765 to the year 1940 is shown in Appendix Table I, an unofficial

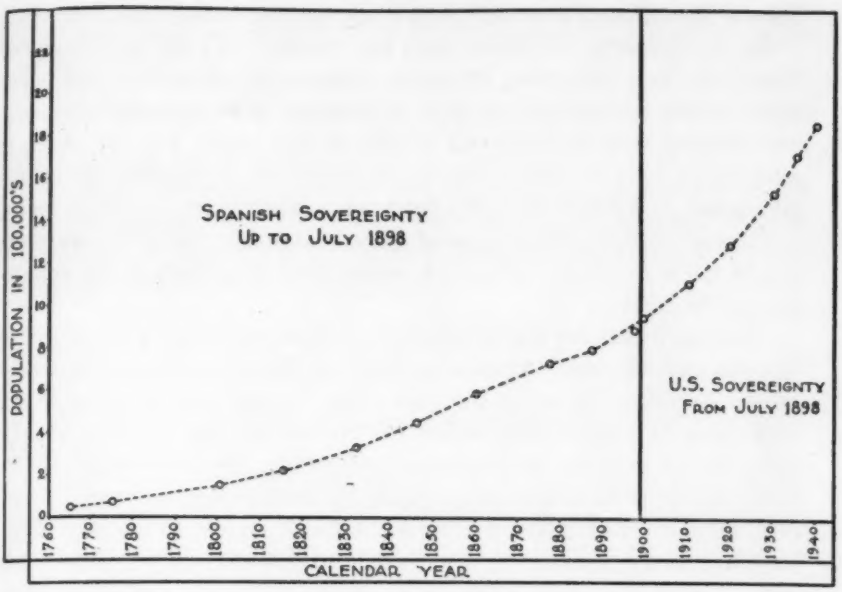

FIG. 1. ENUMERATED POPULATION OF PUERTO RICO, CENSUSES OF 1765 TO 1940

record of the 1897 census being included as a footnote. The average annual rate of increase during each intercensal period is also given, calculated by assuming that for these relatively short periods of time population growth proceeded at a constant rate. In this calculation and in the analysis of the population figures which follows, the value for 1897 has not been included, because it is not in the officially confirmed series. It will, however, be of interest to compare this unofficial count with the estimates made from the analysis of the other observations.

From a value of 4.61 per cent, corresponding to the intercensal period 1765-1775, the average annual rate of increase decreased steadily until it reached a value of 0.87 per cent in the intercensal period of 1877-1887. From then on, it increased from a value of 1.50 per cent during the intercensal period 1887-1899 to a value of 1.89 per cent for the period 1935-1940.

It is therefore evident that there have been two cycles of population growth in Puerto Rico, and that at least during the first cycle the population grew according to a decreasing annual rate of growth. This is clearly shown in Fig. 1, which plots the enumerated population of Puerto

Rico at the different censuses taken from the year 1765 to the year 1940. From this graph the following facts are evident: (1) the smoothness of flow of the lines connecting the points representing the enumerated population at each census, indicates that the censuses were probably taken with considerable accuracy; (2) the course of the points for the censuses taken from 1765 to 1887, inclusive, suggests that during this period the population of Puerto Rico may have been growing on a logistic curve; (3) a reactivation in the process of growth, appearing to start toward the end of the last century, initiated a second cycle of growth in the population of the island.

One might suspect the second cycle to have arisen as a result of the changes that necessarily must have followed the occupation of the island by the American forces in the year 1898. Under this assumption the high value of 1899 which creates the impression that the new growth cycle started prior to the American occupation, might be explained by better enumeration in the 1899 census, by immigration, or both. However, the last census taken during the Spanish regime in the year 1897, according to the historian Coll y Toste, quoted by Davis(3), showed the population of the island as made up of 890,956 souls, excluding 7,014 members of the army, 368 of the navy, and 1,101 prisoners. The position of the point representing this census in Fig. 1, indicates that the departure from the first cycle noted in the 1899 census, was present also in the 1897 census, and it appears that the transition to the second cycle of growth was probably during the period immediately preceding the occupation of the island by the forces of the United States, and not in the period following it. We shall therefore study the population growth in the following steps:

a. Describe the first cycle of growth of the island of Puerto Rico, using the censuses of 1765 to 1887;

b. Describe the second cycle of growth using the censuses of 1899 to 1940;

c. Investigate the factors underlying the second cycle in the growth of the island's population.

a. Description of growth: 1765-1887

As indicated earlier, the declining percentage increase in the succeeding intercensal periods suggested that a logistic curve might describe this first period of population growth on the island. In fitting the logistic

curve, the growth was considered as starting from zero, and the equation had the form:

$$y = \frac{K}{1+e^{a+bt}} \qquad (1)$$

where y is population at time t.

After a first approximation of the constants was made by the graphical method (4), the values were corrected by the least squares method of successive approximations, y deviations being minimized The final equation thus obtained was:

$$y = \frac{10.99}{1 + 6.536e^{-0.0330t}} \qquad (2)$$

where y represents population in hundred thousands and t time in years, measured from July 1, 1800.

Table 1 shows the observed population at each census taken during the period 1765-1887 as compared with the population calculated by sub-

TABLE 1

Population as enumerated and as calculated from the fitted logistic, Puerto Rico, 1765 to 1887

CENSUS DATE	POPULATION IN HUNDRED THOUSANDS		
	Observed	Calculated	Deviations: Obs.-Calc.
1765	.45	.50	—.05
1775	.70	.69	+.01
1800	1.55	1.46	+.09
1815	2.21	2.21	.00
1832	3.30	3.36	—.06
1846	4.48	4.52	—.04
1860	5.83	5.78	+.05
1877	7.32	7.26	+.06
1887	7.98	8.03	—.05

stituting the time of each census in equation (2). The exact dates of the censuses in this period are not known, and in the calculation they were assumed to be July 1.

It is evident from an inspection of the deviations, that equation (2) gives an excellent description of the observations. The standard deviation of the observed values about the curve is given by:

$$\sigma_{y \cdot x} = \sqrt{\frac{\Sigma \text{ (dev.)}^2}{\text{Degrees of freedom}}} = \sqrt{\frac{.0245}{9-3}} = \pm \begin{matrix} .064 \text{ hundred thousand,} \\ \text{or } 6{,}400 \text{ people} \end{matrix}$$

A point of interest coming out of this description of the past censuses is that the inherent rate of growth of the population of Puerto Rico during this first cycle, 3.30 per cent per year, is almost identical with the corresponding rate, 3.22 per cent per year, determined for the population of the United States by Pearl, Reed and Kish (5). In other words, the populations of Puerto Rico and of the United States started their growth at almost the same rate.

If the population of Puerto Rico had continued undisturbed in its growth process according to the evidence afforded by this first cycle, it would have become stationary at an upper limit of 1,099,000 inhabitants, having attained half this growth by the year 1857. This would have given the island (area, 3400.6 square miles) a maximum density of population of 323 persons per square mile. Actually, according to the 1940 census the density was 550 persons per square mile and was still increasing. This departure from the growth process characteristic of the censuses of 1765 to 1887 will now be considered.

b. Description of growth: 1899-1940

The steady decrease in the annual rate of increase during the period 1765-1887, which suggested that the population could be described by a logistic curve, is not seen during the period 1899 to 1940 (Appendix Table I). The average annual rate of increase shows no tendency to slow down, except for the last intercensal period, 1935-1940, when the average annual rate of growth drops from 1.95 per cent in the preceding period of 1930-1935, to 1.89 per cent. It is possible, therefore, that a superficial inspection of this second cycle, without a retrospective look at past experience, might lead us to think that we are dealing with a Malthusian population, or even perhaps with an accelerated exponential growth. It should be noticed, however, that although this is a new cycle of growth, the average annual rate of increase is being measured relative to the lower asymptote of the first cycle, namely, the line $y = 0$. If we could make an estimate of the lower asymptote of this second

cycle, which theoretically represents the level from which the reactivation of the growth process producing this second cycle started, we could calculate the average annual rate of growth for the different intercensal periods involved, on a more rational basis.

A careful inspection of Fig. 1 suggests that the lower asymptote of this second curve must be a population in the neighborhood of 700,000. If for our purposes we consider that this is a satisfactory level from which to measure the average annual rate of increase in population during this second cycle, we should measure this relative increase exclusive of the base population of 700,000.

The results of this adjustment, shown in Appendix Table 2, give a decreasing average annual rate of growth from 4.93 per cent in the first intercensal period to 3.11 per cent in the last. This decrease suggests that the second cycle is growing in a way similar to the first and that we are justified in postulating a logistic curve for this period also. The level of this rate is a little higher than that of the first cycle, which creates the impression that the population is increasing now at an even faster rate than during the first cycle. It must be remembered however that by excluding the base population of 700,000 we segregated from our computations that group which theoretically was not contributing to the growth but was simply reproducing itself. This left us with a selected growing group as the only element of the population on which the growth rate is determined.

The equation of the logistic to be fitted to the population during this interval differs from that fitted to the first period of 1765-1887 in having an additive constant. This is due to the fact that in the first period the lower asymptote was the time axis. For the second period of growth, however, the lower asymptote (roughly estimated above as 700,000) is the line $y = d$, and the equation to be fitted to this interval will therefore be of the form:

$$y = d + \frac{K}{1+e^{a+bt}} \tag{3}$$

where y is population at time t.

The constants were determined by a graphical procedure, advantage being taken of the logarithmic transformation of equation (3):

$$\log_e \frac{K-(y-d)}{y-d} = a + bt \tag{4}$$

The upper and lower asymptotes were first estimated by determining, by inspection, the values of K and d which gave the most satisfactory straight line when the function of the observed y values on the left hand side of equation (4) was plotted against time. The fact that for this second period of growth we have not yet accumulated enough evidence to obtain a good estimate for the upper asymptote, makes the problem of fitting difficult, but a first approximation to the logistic curve that fits the observations was obtained. Its equation is:

$$y = 6.5 + \frac{30}{1 + 8.544e^{-.0441t}} \qquad (5)$$

where y represents population in hundred thousands, and t time in years, measured from July 1, 1900.

Table 2 presents the observed population at each census taken during the period 1899 to 1940, and the population calculated as of the exact date of each census from equation (5).

TABLE 2

Population as enumerated and as calculated from the fitted logistic, Puerto Rico, 1899 to 1940

CENSUS DATE	POPULATION IN HUNDRED THOUSANDS		
	Observed	Calculated	Deviations: Obs.-Calc.
Nov. 10, 1899	9.53	9.565	—.035
Apr. 15, 1910	11.18	11.081	+.099
Jan. 1, 1920	13.00	13.001	—.001
Apr. 1, 1930	15.44	15.599	—.159
Dec. 1, 1935	17.24	17.249	+.009
Apr. 1, 1940	18.69	18.597	+.093

The deviations are seen to be small and accumulate to give a standard deviation:

$$\sigma_{y \cdot s} = \sqrt{\frac{\Sigma\ (\text{dev.})^2}{\text{Degrees of freedom}}} = \sqrt{\frac{.0450}{6\text{-}4}} = \pm \begin{matrix} 0.15 \text{ hundred thousand,} \\ \text{or } 15{,}000 \text{ people} \end{matrix}$$

Fitting by least squares was considered over-elaborate in view of the small number of observations, and the fitted curve may not be considered

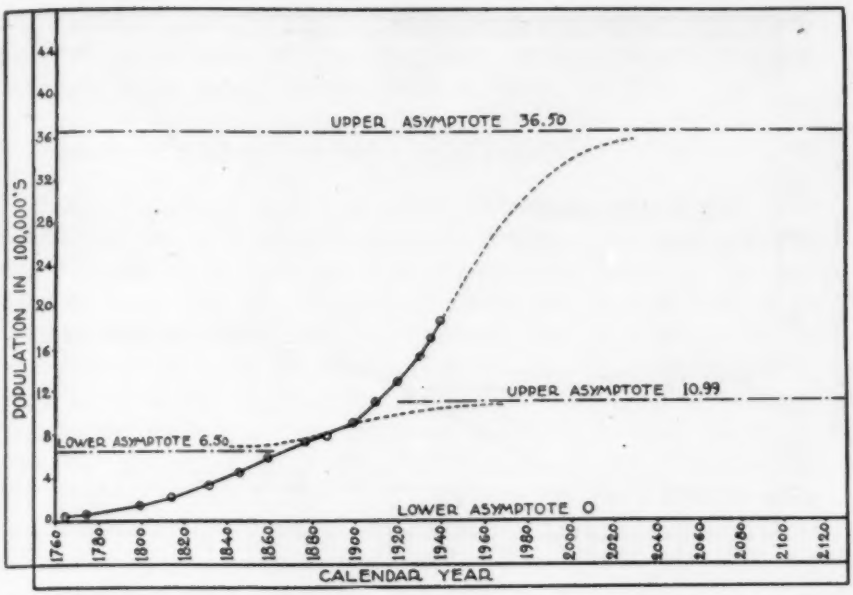

FIG. 2. THE POPULATION GROWTH OF PUERTO RICO FITTED WITH TWO SYMMETRICAL GROWTH CURVES

well enough established to warrant its use in long term predictions. When one or two more census counts are available it should be possible to estimate future growth with greater confidence. Nevertheless, the present curve furnishes a good description of the trend of growth over the past 40 years, and certain points of interest emerge.

The inherent rate of growth of the population in this second cycle is 4.41 per cent per year as compared to an inherent rate of growth of 3.30 per cent per year in its first cycle. However, it should be recalled that during the second cycle we have measured growth relative to a selected group of the population, which may account for the higher rate.

Although for the reasons stated above, the upper limit of growth is subject to a greater standard error, there is no doubt, from the evidence afforded by the observations, that the population in Puerto Rico is still far from attaining a stationary level and that our present population represents a point possibly not much more than halfway in the evolution of the second cycle. In other words, if the present growth of population on the island continues its course unaltered, we must expect our population to increase considerably with the flow of time.

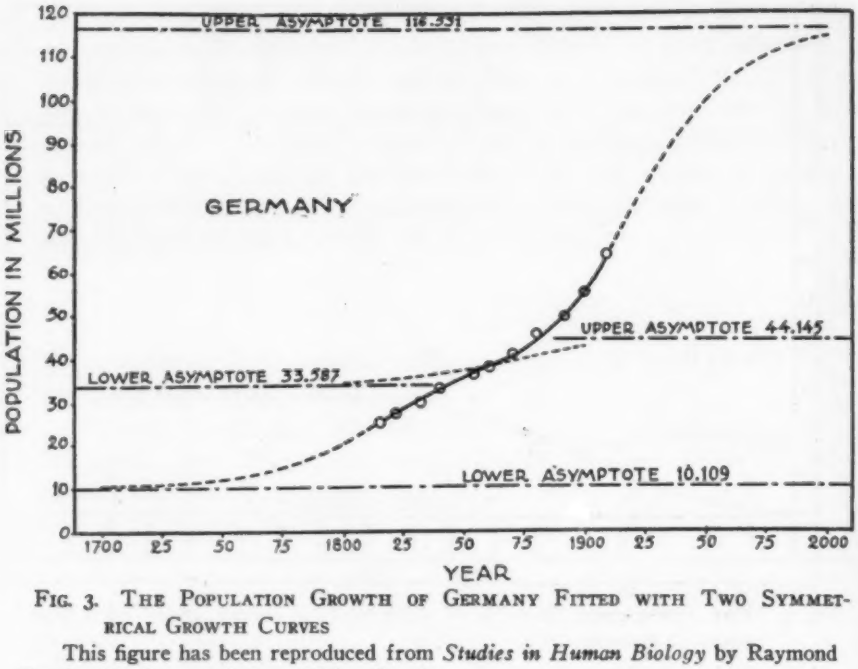

FIG. 3. THE POPULATION GROWTH OF GERMANY FITTED WITH TWO SYMMETRICAL GROWTH CURVES

This figure has been reproduced from *Studies in Human Biology* by Raymond Pearl, with the permission of Mrs. Pearl.

Fig. 2 shows the population growth of Puerto Rico fitted with the two logistic curves we have discussed above. The curves were welded by computing for each of the 12 years following the 1887 census, the weighted average of the two curves, using the second curve with the weight $t/12$ and the first with the weight $(12—t)/12$, where t is the number of years beyond 1887.

The cyclical character of population growth is not a new phenomenon in population studies. Pearl and Reed have stated that "in all countries of Europe certainly, the present epoch or cycle of population growth starts from a lower asymptote which represents the upper limit of the preceding cycle or epoch."(6) In most cases, however, the data available on population counts for these countries do not cover more than a single cycle of growth. In this respect, the case of Germany is an exception, and its data on the enumeration of its population at different dates reveal the transition from one cycle of growth to another. Fig. 3* shows,

* Reproduced from *Studies in Human Biology* (1), p. 608.

for comparison with Fig. 2, the population growth of Germany fitted with two logistic curves by Pearl and Reed (6), and it is seen to give a strikingly similar picture to that of Puerto Rico.

c. Factors underlying the second cycle of growth

Every human population is in a state of constant change, since with the flow of time, it is suffering losses by deaths and emigration at the same time that it is being increased by births and immigration. The combined effect of these four processes is what makes it grow, decline, or remain stationary. It is therefore pertinent that in investigating the immediate causes of the reactivation of the process of population growth in the island of Puerto Rico, our first steps be directed to see whether there is any evidence about changes in the death, birth or migration rates that may account for it. As a matter of interest, before proceeding to do this, we present in Table 3 the population of Puerto Rico enumerated at each of the censuses taken from 1899 to 1940, as compared with the population that would have been expected at each of these censuses if the growth characteristic of the first cycle had continued.

TABLE 3

Population of Puerto Rico as enumerated 1899 to 1940, and as calculated from the logistic fitted to the observations of the period 1765 to 1887

CENSUS DATE	ENUMERATED POPULATION	CALCULATED POPULATION	EXCESS OF ENUMERATED OVER CALCULATED	
			Number	Per cent
Nov. 10, 1899	953 243	882 801	70 442	7.98
Apr. 15, 1910	1 118 012	936 591	181 421	19.37
Jan. 1, 1920	1 299 809	976 274	323 535	33.14
Apr. 1, 1930	1 543 913	1 008 736	535 177	53.05
Dec. 1, 1935	1 723 534	1 023 156	700 378	68.45
Apr. 1, 1940	1 869 255	1 032 708	836 547	81.00

The tremendous increase in population for the period 1899-1940 which is so evident from Table 3 has been explained by some of the most competent observers as a result of an increasing birth rate and a decreas-

ing death rate. From the excellent study of the problems of the island made in 1930 by the Brookings Institution, we quote:

> "This rapid growth [in population] is the combined result of an increased birth rate and a decreased death rate. The birth rate is almost twice that of the United States as a whole, and is steadily increasing. The death rate, on the other hand, has fallen from an annual average of 29.6 per thousand during the last ten years of the Spanish regime to 22.4 per thousand since 1925 . . . . . "(7)

The authors, however, base their assertion of an increasing birth rate on a superficial examination of the trend exhibited by the recorded birth rates of the island. They apparently overlook the fact that the registration of births in Puerto Rico during this period has been improving and that what appears to be an increase in the birth rate may be found to be, on further analysis, the result of more complete registration of births. We are forced to find some way of evaluating the birth rate which would eliminate the effect of changes in the completeness of registration. For this purpose we have made use of the following equation:

$$\text{Increase in Population} = \text{Births} - \text{Deaths} + \text{Immigration} - \text{Emigration},$$

or transposing the terms,

$$\text{Births} = \text{Increase in Population} + \text{Deaths} - \text{Immigration} + \text{Emigration} \qquad (6)$$

Although the use of this equation for the evaluation of the birth rates may be open to criticism because of the possible incompleteness of death registration, we have reason to believe that in Puerto Rico, during the period under study, registration of deaths was sufficiently accurate to warrant the use of death statistics for this purpose. As soon as our system of vital statistics, which dates back to the year 1885, was centralized in the year 1931, we were admitted to the U. S. Death Registration Area, but not to the Birth Registration Area, which means that it was estimated that at least 90 per cent of the deaths, but not of the births, were registered at that time. Furthermore, the steady downward trend exhibited by our crude death rate during the course of the past forty years is just opposite to what we would expect if there were gross underregistration in the early years. Whoever is familiar with the customs and religious beliefs of the vast majority of our population, as well as with the accessibility of cemeteries, will have no difficulty in understanding the

relative accuracy of death registration in our island even prior to the enforcement of the law of 1931. There has undoubtedly been improvement in the registration of deaths of very young infants, but this would produce a small relative change in the entire number of deaths for all age groups.

Appendix Table 3 presents the reported births and deaths in the island of Puerto Rico from 1887 to 1940. Except for a few instances in which the death figures are exceptionally high, due to the effects of such calamities as major epidemics, hurricanes, etc., the number of annual deaths recorded shows a steady increase, in harmony with the increasing population. Although the number of annual births shows also a steady increase, this increase is out of all proportion to the increase in annual deaths. A close examination of the history of the registration system and enforcement shows clearly that registration of births has greatly improved during this period and that it would be unjustified to attempt to evaluate the change in birth rate from these figures.

The role of migration in the population growth of Puerto Rico during its second cycle can be considered negligible for all practical purposes, as can be seen from Appendix Table 4 which presents the balance of immigration to and emigration from the island, from the fiscal year 1908-09 to the fiscal year 1940-41. For the entire period of thirty-two years, the net loss was 53,714, and the largest net change in any single year was the loss of 8,729 in 1926-27.

The computation of the average annual births and birth rates for the different intercensal periods from 1899 to 1940, using the relationship between births, deaths, migration and increase in population expressed by equation (6) is given in Tables 4 and 5.

These tables bring out some facts of the utmost importance in understanding the dynamics of the processes that led to the increase in population initiating a second cycle of growth on an island whose natural resources were scarcely enough to support the stationary level approached during the first cycle of growth. These facts are:

1. The trend of the estimated birth rate has been almost stationary, with perhaps a small tendency in the direction of a decrease rather than an increase;
2. The birth rate expressed per 1000 female population of age 15-45 indicates that there has been no substantial change in the fertility of the island's female population;

TABLE 4

Computation of estimated average annual births from intercensal population increase, recorded deaths and migration, Puerto Rico, 1887-1940

INTERCENSAL INTERVAL	YEARS IN INTERVAL	POPULATION INCREASE DURING INTERVAL	DEATHS DURING INTERVAL	MIGRATION DURING INTERVAL	ESTIMATED BIRTHS DURING INTERVAL	ESTIMATED AVERAGE ANNUAL BIRTHS DURING INTERVAL
1887-1899	12.36	154 678	339 995	?	494 673	40 022
1899-1910	10.43	164 769	273 139	?	437 908	41 985
1910-1920	9.71	181 797	281 470	—10 415	473 682	48 783
1920-1930	10.25	244 104	322 258	—37 751	604 113	55 938
1930-1935	5.67	179 621	186 167	+ 4 835	360 953	63 660
1935-1940	4.33	145 721	149 500	—14 796	310 017	72 227

TABLE 5

Computation of estimated average annual birth rate and rate of natural increase, Puerto Rico, 1887-1940

INTERCENSAL INTERVAL	AVERAGE ANNUAL BIRTHS DURING INTERVAL		AVERAGE ANNUAL RECORDED DEATHS	AVERAGE INTERCENSAL POPULATION	ESTIMATED AVERAGE ANNUAL BIRTH RATE PER 1000	AVERAGE ANNUAL DEATH RATE PER 1000	ESTIMATED RATE OF NATURAL INCREASE PER 1000	AVERAGE INTERCENSAL FEMALE POPULATION AGE 15-45	ESTIMATED BIRTH RATE PER 1000 FEMALES AGE 15-45
	Recorded	Estimated							
1887-1899	24 750	40 022	27 508	875 904	45.7	31.4	14.3		
1899-1910	31 591	41 985	26 188	1 035 628	40.5	25.3	15.2	238 428	176.1
1910-1920	44 127	48 783	28 988	1 208 911	40.4	24.0	16.4	275 242	177.3
1920-1930	52 758	55 938	31 440	1 421 861	39.3	22.1	17.2	324 420	172.4
1930-1935	63 932	63 660	32 834	1 633 724	39.0	20.1	18.9	377 726	168.5
1935-1940	69 573	72 227	34 526	1 796 394	40.2	19.2	21.0	415 061	174.0

3. Migration has not contributed to the increase in population, for the balance is in favor of emigration and not of immigration;
4. The crude death rate in the island has shown a steady, uninterrupted decrease.

The above facts leave us with but one explanation for the reactivation of the process of growth of the island's population, and that is that it has been brought about by a decreasing death rate. (Evidence that this decrease represents a real change in mortality risks will be presented in the next section.) The implications of this assertion are very serious. It means that so far, the evolution of the island along the line of public health activities has far outstripped its evolution along the lines that are associated with a decreasing fertility, namely, socio-economic conditions, education, etc. Under these circumstances, public health activities are acting as a sort of boomerang against the welfare of the island. This does not mean at all that we should move backward and not forward in the movement toward a better civilization, by letting the death rate once more assume the proportions of times long past. It means that we should work to promote in every way possible, those measures that experience has shown will result in a substantial decrease in the fertility of the population. If the public health program proceeds on this broader basis, the course of the second cycle of growth may be substantially altered from that indicated at present, and a better balance between population and resources attained.

PART II. TIME CHANGES IN THE LIFE TABLES FOR PUERTO RICO, 1910 to 1940

The marked decrease in the crude death rate noted in the preceding discussion, requires further analysis before its implications are understood. It is a well-known fact that crude death rates are greatly affected by the age composition of the population. With age specific death rates remaining constant, a population may exhibit a decreasing crude death rate simply because its age composition has changed in such a way as to improve its general mortality experience, and it is therefore necessary to study the trend in mortality specific for age.

From the available statistical records, the average annual deaths by age groups for each three-year period centering around a census year were computed for the census years 1910 to 1940. It was impossible for us to obtain the necessary data to construct life tables for periods centering around censuses prior to that of 1910, and data specific for sex were

not available prior to the period centering at 1930. Life tables by race or color were left out of consideration because in our judgment the inaccuracies in reporting this item on the death certificates are too great to warrant their use.

Most mortality statistics by age groups for the island of Puerto Rico are given in the groups: under 1, 1 to 4, in 5-year groups from age 5 to 34, in 10-year groups from age 35 to 74, and in one single group from 75 years on, and abridged life tables based on these groupings were constructed. There were instances in which the age distribution did not conform to this pattern and deaths had to be redistributed in order to be consistent in the groupings and make the life tables comparable. In such instances the method of finite differences was used in splitting the central group of three consecutive groups of deaths of equal age intervals. Appendix Tables 5a to 5f show the raw data for the deaths, and the derived averages are shown in Appendix Tables 8 to 12.

The population by age, as of the day representing the center of each three-year period, was calculated by arithmetic interpolation between two consecutive censuses and by arithmetic extrapolation beyond the last census. Appendix Table 6 gives the enumerated population from which these estimates were made, and the estimated population is presented in the life tables (Appendix Tables 8 to 12).

For the construction of the abridged life tables we followed the method described by Reed and Merrell (8), taking advantage of the tables of the function ${}_nq_x$ which facilitate the computation of the probability of a person age x dying within the interval x to $x+n$ from the corresponding age specific death rate.

Every person familiar with the construction of life tables is well aware of the difficulties involved in the computation of the probability of dying during the first year of life, q_0. Our case was no exception to the rule. The method described by Dublin and Lotka (9) could not be used because the data needed were not obtainable. The equation for q_0 in terms of m_0 determined by Reed and Merrell (8), which aimed at a correction for the underenumeration of population in this age interval, was found convenient to describe the risk of dying during the first year of life in the life tables for the years 1934-36 and 1939-41, when Puerto Rico was included in the U. S. Death Registration Area. But prior to this the underregistration of deaths occurring during the first year of life was considerable and this equation underestimates the risk in such a case.

Examining all the evidence, we concluded that a better estimate of the probability of dying during the first year of life in the periods prior to that of 1934-36 was given by the average infant mortality for the period, which assumes that the error in the numerator of the fraction balances that in the denominator. Appendix Table 7 presents the data and computation for the average infant mortality for these periods.

With the values of ${}_nq_x$ determined, the survivorship to age x, l_x, and the deaths within the interval x to $x+n$, ${}_nd_x$, were immediately obtainable.

For the first ten years of life, the life table population, ${}_nL_x$, was computed from the formulas given by Reed and Merrell (8). Since the age intervals in the life table after age 10 were not uniform, the values of ${}_nL_x$ from this point on were determined by the procedure used by Greville (10), namely:

$$ {}_nL_x = {}_nd_x/{}_nm_x $$

For the final age interval of indefinite length, 75 years and over, this becomes:

$$ {}_\infty L_{75} = l_{75}/{}_\infty m_{75} $$

The expectation of life, $\mathring{e}_x$, was computed by the usual formula:

$$ \mathring{e}_x = T_x/l_x $$

where T_x is the sum of the life table population beyond age x.

Appendix Tables 8 to 12 present the data and the abridged tables from 1909-11 to 1939-41. A comparison of each life table function for all the tables brings out the real features of the time changes. The risks of dying in Puerto Rico have been decreasing steadily in all age groups, thus confirming the statement previously made that the decrease in the crude death rate experienced by our island in the course of the last decades has been the result of a decrease in the mortality risks of the community and not of a favorable change in the age composition of its population. For the thirty-year period the largest percentage decline (45 per cent) is for the age group 10-14, and this decreases with age to a 14 per cent decline for the age group 65-74. The effect of these decreasing mortality risks is perhaps more clearly seen in the survivorship to exact age x out of a group of 100,000 born alive, and in the expectation of life or average years of life remaining to survivors to age x, as these functions have changed throughout the course of the thirty-year interval covered by these tables. If the 100,000 live births were exposed throughout their lives to the mortality risks expressed by the life table for the

period 1909-11, before reaching their fifth birthday, they would have been reduced by death by more than 25 per cent, while if they had been exposed instead to the mortality risks expressed by the 1939-41 life tables, the reduction by death would not have reached the 25 per cent level until after their fifteenth birthday. Furthermore, the expectation of life at birth, for both sexes, has been increased by over seven years during this thirty-year period. In other words, the average person born and living throughout his life under present conditions might expect to live over seven years more than the average person who was born and lived his life exposed to the mortality risks prevailing on the island during the period 1909-11.

However, in spite of the improvement in the health conditions of the island suggested by these time changes, we must face the challenge of other countries in evaluating our achievements. Although the expectation of life increased substantially in Puerto Rico during the thirty years elapsed between 1910 and 1940, much still must be done in order to approach the level attained by the white population of continental United States (11), which had in 1940 an expectation of life at birth eighteen years greater for the males and twenty years greater for the females than the corresponding groups for Puerto Rico. Even the colored population of the United States had an expectation of life at birth eight years greater than the Puerto Rican population in 1940.

A more complete picture of the situation may be had by looking at Fig. 4, which presents for comparison, the survivorship curves plotted from the following life tables:

(1) Puerto Rico, all classes, 1909-11;
(2) Puerto Rico, males and females, 1939-41;
(3) United States, white males and females, and colored males and females, 1939-41.

Many interesting facts are disclosed by this graph. First, it offers very good evidence of the improvement in the health conditions of the island that has taken place in recent years. At the same time, it shows us the further improvement necessary to bring our specific death rates down to the level attained in one of the more advanced countries. It clearly points out that the greatest concern in our efforts to promote better health conditions in our island should be with the population in the younger age groups, i. e., infancy and childhood. According to this graph, if we could follow throughout their lives groups of 100,000 babies born alive at the same time, and dying off according to the 1939-41 risks,

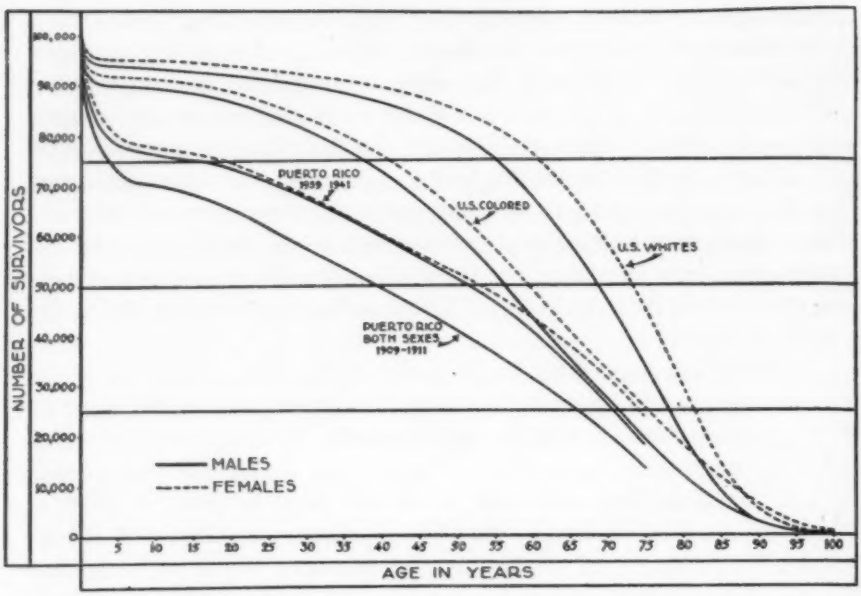

FIG. 4. NUMBER OF SURVIVORS OUT OF 100,000 BORN ALIVE: PUERTO RICO, 1939-1941 AND 1909-1911; UNITED STATES, 1939-1941.

in the island of Puerto Rico and in continental United States, we would find that in Puerto Rico, by its fifth year of life, the group would have been reduced by death more than 20 per cent, while in the United States the group of white babies would have been reduced by only 5 per cent, and that of colored babies by 9 per cent. While in the United States, a little over 75 per cent of the original 100,000 live births would be still alive at age 60 if they were white females, at 55 if white males, at 40 if colored females, and at 37 if colored males, in Puerto Rico, in both the male and the female groups, the age at which 75 per cent would still be alive and 25 per cent dead, would be reached shortly after the group had celebrated its fifteenth birthday.

One more interesting fact brought out by Fig. 4 is that in Puerto Rico, sex differentials in mortality are not as pronounced as in continental United States. The reason for this, in our judgment, should be sought for in a study of the most important causes of death in the island. Such a study is already in progress.

SUMMARY

This paper has presented an analysis of population growth in Puerto Rico and the relation of this growth to time changes in the vital statistics of the island. The observations on which this study is based cover the period between the first official census of the island, taken during the Spanish regime in the year 1765, and the last official census taken in the year 1940 under the United States regime.

During this period the population growth of the island presents definite evidence of two cycles. The first, already in progress by the year 1765, shows at some time during the period 1887 to 1897, a transition to a second cycle, which at present is still in progress.

An analysis of the first cycle showed that the observations for this period could be fitted very satisfactorily by a logistic curve of the type so extensively used to describe the growth of populations. The equation of this curve indicated that the population of Puerto Rico started to grow at an annual rate of 3.3 per cent, which is practically the same as the rate at which the population of continental United States started its growth process. The rate of growth decreased steadily, and the population of the island was apparently approaching a limit of about 1,100,000 inhabitants prior to the changes which initiated a new wave of growth.

A superficial inspection of the second cycle of growth suggested the possibility that during this period the population has been growing at a nearly constant rate, as postulated by the Malthusian theory, but a more critical analysis revealed good reason to believe that we were dealing here with another logistic curve in its first phases of growth. A curve of this type was, therefore, fitted to the observations and found to give a good description of them. However, due to the small number of observations accumulated during this second phase, the equation of the fitted logistic should not be used in long term predictions of population, until in the light of new evidence it can be properly revised. The inherent rate of growth obtained from this equation for the second cycle is 4.4 per cent per year. This rate may be expected to decrease steadily with time unless the conditions under which the population is growing at present are seriously disturbed.

An inquiry as to the factors that influenced the population growth of the island to the extent of producing a second cycle showed that we must attribute the whole thing to a steadily declining death rate while the birth rate remained virtually stationary.

To examine the changes in mortality more completely, life tables were constructed for as far back as reliable data were available. From these life tables, covering the period 1910 to 1940, we can clearly see how mortality risks in Puerto Rico have steadily declined in all age groups. This decrease has manifested itself in an increase in the expectation of life at birth from 38.4 years in 1910 to 46.0 years in 1940. Nevertheless, there is still much to be done in the realm of public health if we want our mortality risks to compare favorably with those of the more advanced countries. A better idea of the tasks ahead may be had if we realize that in the year 1940 the expectation of life at birth of the white population of the United States exceeded ours by about 20 years.

As the sole factor responsible for the new growth wave, which has created so many problems of maladjustment of population to resources, has been found to be a steadily decreasing death rate and an almost stationary high birth rate, we must conclude that the development in those factors affecting the fertility of our people, such as education, and standard of living, has not kept pace with the progress made by the public health activities directed at a reduction in death rates. If further improvement in the death rate is not to result in still more serious problems associated with over-population, there must be a decrease in the fertility rate as well. This means that the various agencies concerned with the welfare of the island should focus their attention on ways to bring this about and not concentrate solely on efforts to reduce mortality.

BIBLIOGRAPHY

1. Pearl, R. Studies in Human Biology, Chapters XXI, XXIV, and XXV. Williams and Wilkins, *Baltimore*, 1924.
2. Truesdell, L. E. The Population Census of Puerto Rico. *Estadistica—Journal of the Inter-American Statistical Institute*, 1: No. 3, 26-32, September, 1943.
3. Davis, Brigadier General George W., U. S. V. Report on Civil Affairs of Puerto Rico, 1899, p. 158. Government Printing Office, *Washington, D. C.*, 1900.
4. Pearl, R. Medical Biometry and Statistics, Chapter XVIII, Third Edition, Revised and Enlarged. W. B. Saunders, *Philadelphia*, 1940.
5. Pearl, R., Reed, L. J. and Kish, J. F. The Logistic Curve and the Census Count of 1940. *Science*, 92; 486-488, November 22, 1940.
6. Pearl, R., and Reed, L. J. The Growth of Human Population, from *Studies in Human Biology*, by Pearl, R., Chapter XXV, p. 588. William and Wilkins, *Baltimore*, 1924.
7. Clark, V. S., *et al.* Puerto Rico and Its Problems, Introduction and Summary

of Recommendations, p. xxiv. The Brookings Institution, *Washington, D. C.*, 1930.

8. Reed, L. J. and Merrell, M. A Short Method for Constructing an Abridged Life Table. *American Journal of Hygiene*, 30A: 33-62, September, 1939.
9. Dublin, L. I., and Lotka, A. J. Length of Life, Chapter XIV. Ronald Press Co., *New York*, 1936.
10. Greville, T. N. E. Short Methods of Constructing Abridged Life Tables. *The Record, American Institute of Actuaries*, Vol. 32, Part 1, No. 65, June, 1943.
11. Bureau of the Census. United States Life Tables 1939-1941. *Vital Statistics Special Reports*, 19; No. 4, 33-45, January 11, 1944. Bureau of the Census, *Washington, D. C.*

APPENDIX

APPENDIX TABLE 1

Population of Puerto Rico and annual rate of increase during each intercensal period: 1765 to 1940[1]

CENSUS DATE	POPULATION ALL CLASSES	ANNUAL RATE OF INCREASE (PER CENT)
1765	44 883	—
1775	70 250	4.61
1800	155 426	3.20
1815	220 892	2.34
1832	330 051	2.42
1846	447 914	2.17
1860	583 308	1.92
1877	731 648	1.32
1887	798 565	.87
Nov. 10, 1899	953 243	1.50
Apr. 15, 1910	1 118 012	1.54
Jan. 1, 1920	1 299 809	1.56
Apr. 1, 1930	1 543 913	1.69
Dec. 1, 1935	1 723 534	1.95
Apr. 1, 1940	1 869 255	1.89

Note: The population enumerated by the census of 1897 quoted from an unofficial source is given as: 890,956 souls, excluding 7,014 members of the army, 368 of the navy, and 1,101 prisoners. See reference (3).

[1] Data for the censuses taken under the Spanish regime from 1765 to 1887 inclusive, obtained from the War Department, Office Director Census of Porto Rico — Report on the Census of Porto Rico, 1899, page 40. Government Printing Office, *Washington*, 1900. Data for the censuses taken during the U. S. regime obtained from the official releases of the U. S. Census Bureau.

APPENDIX TABLE 2

Annual rate of growth for each intercensal period from 1899 to 1940 of the population in excess of 700,000 persons in Puerto Rico

CENSUS DATE	POPULATION IN 100,000's	POPULATION IN 100,000's IN EXCESS OF 7.00	INTERCENSAL PERCENTAGE INCREASE OF POPULATION IN EXCESS OF 7.00	LENGTH OF INTERCENSAL INTERVAL IN YEARS	ANNUAL PERCENTAGE INCREASE OF POPULATION IN EXCESS OF 7.00
Nov. 10, 1899	9.53	2.53			
Apr. 15, 1910	11.18	4.18	65.217	10.43	4.93
Jan. 1, 1920	13.00	6.00	43.540	9.71	3.79
Apr. 1, 1930	15.44	8.44	40.666	10.25	3.39
Dec. 1, 1935	17.24	10.24	21.327	5.67	3.47
Apr. 1, 1940	18.69	11.69	14.160	4.33	3.11

APPENDIX TABLE 3

Reported[1] annual births and deaths in Puerto Rico, 1887 to 1940

YEAR	DEATHS[2]	BIRTHS[2]	YEAR	DEATHS[2]	BIRTHS[2]
1887	?	?	1914	22 343	47 578
1888	25 568	27 401	1915	25 115	45 268
1889	26 255	25 113	1916	29 491	43 360
1890	26 955	24 231	1917	38 675	44 396
1891	24 089	23 496	1918	39 299	52 003
1892	24 474	25 302	1919	30 570	46 285
1893	21 616	25 457	1920	29 918	50 416
1894	24 896	24 548	1921	30 015	51 190
1895	26 284	25 090	1922	29 666	50 830
1896	25 435	26 270	1923	27 143	51 162
1897	31 980	25 827	1924	27 332	53 876
1898	33 614	19 719	1925	33 519	53 059
1898-9	39 918	?	1926	32 946	56 675
1899-1900	44 023	?	1927	30 500	50 746
1900-1	35 800	19 930	1928	35 467	56 708
1901-2	24 500	25 898	1929	38 534	52 468
1902-3	25 553	30 123	1930	28 870	54 574
1903-4	23 100	40 053	1931	32 146	65 700
1904-5	23 700	28 472	1932	35 610	66 436
1905-6	21 100	32 226	1933	36 763	61 655
1906-7	27 125	34 778	1934	31 703	65 595
1907-8	23 500	34 701	1935	30 753	67 585
1908-9	22 000	38 105	1936	34 788	68 962
1909	22 274	37 444	1937	37 132	67 919
1910	26 675	37 706	1938	33 870	69 823
1911	26 579	39 106	1939	32 631	73 044
1912	27 152	40 708	1940	34 477	72 388
1913	23 307	42 994			

[1] From 1931 on, late registrations are excluded.

[2] Births and deaths for the years 1887 to 1898 obtained from: War Department—Office Director Census of Porto Rico—Report on the Census of Porto Rico, 1899, pp. 112-113. Government Printing Office, *Washington, D. C.*
For the following years and up to the present, the information was obtained from the Reports of the Commissioner of Health to the Governor of Puerto Rico.

APPENDIX TABLE 4

Balance of immigration minus emigration, Puerto Rico, fiscal years 1908-09 to 1940-41[1]

FISCAL YEAR	NET GAIN	NET LOSS	FISCAL YEAR	NET GAIN	NET LOSS
1908-09	3 111		1925-26		5 621
1909-10	3 500		1926-27		8 729
1910-11	1 475		1927-28		6 144
1911-12	195		1928-29		4 637
1912-13	22		1929-30		5 576
1913-14		588	1930-31	1 938	
1914-15		339	1931-32	2 708	
1915-16	33		1932-33	1 082	
1916-17		2 354	1933-34	2 966	
1917-18		4 212	1934-35		1 017
1918-19		3 312	1935-36		3 448
1919-20		4 139	1936-37		4 518
1920-21	612		1937-38		2 362
1921-22	633		1938-39		4 488
1922-23		1 756	1939-40		1 904
1923-24		3 720	1940-41		988
1924-25		2 137			
			Total	18 275	71 989

[1] Source: U. S. Department of Justice, Immigration and Naturalization Service.

APPENDIX TABLE 5a

Deaths by age in Puerto Rico
All classes, calendar years 1909, 1910 and 1911[1]

AGE IN YEARS	1909	1910	1911
Under 1	5 413	6 399	6 370
1	2 340	3 232	3 314
2-4	2 102	2 967	3 179
5-9	1 083	1 331	1 314
10-14	684	763	728
15-19	855	983	991
20-24	1 276	1 430	1 421
25-29	1 248	1 396	1 423
30-39	1 826	2 042	2 220
40-49	1 504	1 596	1 813
50-59	1 247	1 398	1 432
60-69	1 069	1 257	1 294
70-79	880	968	1 080
80-89	504	624	659
90-99	168	226	245
100 and over	43	41	46
Not specified	20	21	20
All ages	22 262	26 674	27 549

[1] Obtained from the unpublished records of the Bureau of Vital Statistics of the Insular Department of Health, *San Juan, Puerto Rico.*

APPENDIX TABLE 5b

Deaths by age in Puerto Rico
All classes, January to June, July to December, 1919, 1920, and 1921[1]

AGE IN YEARS	1919		1920		1921	
	January to June	July to December	January to June	July to December	January to June	July to December
Under 1	3 237	3 595	3 839	3 992	3 794	3 977
1	1 216	1 640	1 257	1 472	1 438	1 958
2-4	1 312	1 457	1 263	1 368	1 239	1 535
5-9	893	863	704	659	676	737
10-14	485	432	372	370	397	411
15-19	664	568	578	582	568	581
20-24	1 107	816	1 031	874	856	844
25-29	836	797	851	719	798	726
30-39	1 501	1 268	1 406	1 262	1 285	1 231
40-49	1 193	1 092	1 065	1 068	952	921
50-59	1 026	890	923	898	818	843
60-69	789	790	743	663	706	766
70-79	620	617	570	540	550	536
80-89						304
90-99	430	436	417	432	420	116
100 and over						32
Not specified	—	—	—	—	—	—
All ages	15 309	15 261	15 019	14 899	14 497	15 518

[1] From the Reports of the Commissioner of Health of Puerto Rico for the fiscal years, 1918-1919, 1919-1920, 1920-1921, and 1921-1922. Bureau of Insular Affairs, U. S. War Dept. Government Printing Office, *Washington, D. C.*, 1919, 1920, and 1923.

APPENDIX TABLE 5c

Deaths by age in Puerto Rico
Males, females, and both sexes, fiscal year July 1, 1929 to June 30, 1930[1]

AGE IN YEARS	MALES	FEMALES	BOTH SEXES
Under 1	3 792	3 185	6 977
1-4	3 317	3 310	6 627
5-9	971	854	1 825
10-14	423	289	712
15-19	557	723	1 280
20-24	952	977	1 929
25-29	702	826	1 528
30-39	1 194	1 389	2 583
40-49	1 230	1 038	2 268
50-59	1 150	776	1 926
60-69	1 141	838	1 979
70-79	817	723	1 540
80-89	536	588	1 124
90-99	239	341	580
100 and over	3	—	3
Not specified	14	6	20
All ages	17 038	15 863	32 901

[1] From the Report of the Commissioner of Health of Puerto Rico for the fiscal year ending June 30, 1930, page 24. Bureau of Supplies, Printing and Transportation, *San Juan, Puerto Rico*, 1931.

APPENDIX TABLE 5d

Deaths by age in Puerto Rico
Males, females, and both sexes, calendar year 1931[1]

AGE IN YEARS	MALES	FEMALES	BOTH SEXES
Under 1	4 630	3 902	8 532
1-4	2 741	2 695	5 436
5-9	766	738	1 504
10-14	344	371	715
15-19	541	687	1 228
20-24	899	941	1 840
25-29	590	747	1 337
30-34	531	697	1 228
35-44	1 172	1 208	2 380
45-54	1 233	904	2 137
55-64	1 100	776	1 876
65-74	971	730	1 701
75 and over	1 012	1 220	2 232
All ages	16 530	15 616	32 146

[1] From the Report of the Commissioner of Health of Puerto Rico for the fiscal year ending June 30, 1932, page 46. Bureau of Supplies, Printing, and Transportation, *San Juan, Puerto Rico*, 1933.

APPENDIX TABLE 5e

Deaths by age in Puerto Rico
Males, females, and both sexes, calendar years 1934, 1935, and 1936[1]

AGE IN YEARS	MALE			FEMALE			BOTH SEXES		
	1934	1935	1936	1934	1935	1936	1934	1935	1936
Under 1	4 015	4 228	4 758	3 427	3 522	4 019	7 442	7 750	8 777
1-4	2 907	2 816	3 564	2 705	2 703	3 570	5 612	5 519	7 134
5-9	952	713	661	845	686	657	1 797	1 399	1 318
10-14	372	351	340	371	277	279	743	628	619
15-19	371	450	487	568	578	591	939	1 028	1 078
20-24	1 022	968	1 099	1 051	951	1 089	2 073	1 919	2 188
25-29	625	672	689	749	769	786	1 374	1 441	1 475
30-34	493	486	534	640	575	567	1 133	1 061	1 101
35-44	1 183	1 114	1 267	1 177	1 160	1 213	2 360	2 274	2 480
45-54	1 235	1 174	1 267	837	829	930	2 072	2 003	2 197
55-64	1 209	1 024	1 156	758	666	748	1 967	1 690	1 904
65-74	1 058	959	1 073	803	770	826	1 861	1 729	1 899
75 and over	1 098	1 091	1 176	1 232	1 221	1 442	2 330	2 312	2 618
All ages	16 540	16 046	18 071	15 163	14 707	16 717	31 703	30 753	34 788

[1] From the Reports of the Commissioner of Health of Puerto Rico for the fiscal years 1934-1935, page 64; 1935-1936, page 65, and 1936-1937, page 79. Bureau of Supplies, Printing and Transportation, *San Juan, Puerto Rico,* 1935, 1936, 1937 respectively.

APPENDIX TABLE 5f

Deaths by age in Puerto Rico

respectively.

APPENDIX TABLE 51

Deaths by age in Puerto Rico
Males, females, and both sexes, calendar years 1939, 1940, and 1941[1]

AGE IN YEARS	MALE			FEMALE			BOTH SEXES		
	1939	1940	1941	1939	1940	1941	1939	1940	1941
Under 1	4 536	4 478	4 820	3 688	3 743	4 026	8 224	8 221	8 846
1-4	3 178	3 373	3 610	3 231	3 386	3 529	6 409	6 759	7 139
5-9	650	749	737	606	695	727	1 256	1 444	1 464
10-14	278	316	339	300	326	314	578	642	653
15-19	324	437	459	544	556	543	868	993	1 002
20-24	799	881	886	928	922	906	1 727	1 803	1 792
25-29	669	735	759	801	816	827	1 470	1 551	1 586
30-34	479	590	589	585	586	585	1 064	1 176	1 174
35-44	1 096	1 206	1 239	1 084	1 157	1 117	2 180	2 363	2 356
45-54	1 195	1 237	1 275	908	932	920	2 103	2 169	2 195
55-64	1 127	1 215	1 160	794	796	779	1 921	2 011	1 939
65-74	1 090	1 330	1 273	926	1 014	1 038	2 016	2 344	2 311
75 and over	1 335	1 348	1 340	1 478	1 640	1 684	2 813	2 988	3 024
Not specified	1	4	10	2	—	1	3	4	11
All ages	16 757	17 899	18 496	15 875	16 569	16 996	32 632	34 468	35 492

[1] From Vital Statistics—Special Reports: Puerto Rico, Summary of Vital Statistics, U. S. Dept. of Commerce, Bureau of the Census. 1939—Vol. 10, No. 52, p. 1533, Mar. 21, 1941. 1940—Vol. 14, No. 52, p. 1192, Feb. 9, 1942. 1941—Vol. 18, No. 53, p. 725, May 18, 1943.

APPENDIX TABLE 6

Population of Puerto Rico, by age and sex, according to the censuses of 1899 to 1940[1]

AGE IN YEARS	CENSUS DATE					
	Nov. 10, 1899	April 15, 1910	Jan. 1, 1920	April 1, 1930	Dec. 1, 1935	April 1, 1940
			Males			
Under 1	13 369[2]	20 175[2]	21 852[2]	22 252[2]	27 010[2]	30 242
1-4	63 405[2]	74 038[2]	79 046[2]	91 793[2]	97 795[2]	112 047
5-9	72 920	76 572	99 150	113 532	120 847	127 791
10-14	65 112	74 280	85 702	101 375	113 682	114 496
15-19	42 919	53 388	60 183	87 907	88 071	99 460
20-24	41 664	53 492	62 114	74 461	100 573	102 464
25-29	39 469	45 836	44 138	47 519	60 496	72 263
30-34	31 365	35 331	37 540	46 720	43 573	52 012
35-44	46 430	58 822	69 612	83 220	90 482	94 268
45-54	29 578	35 844	50 246	54 487	61 798	66 825
55-64	16 758	18 237	23 984	29 793	33 084	36 808
65-74	6 264	7 768	9 553	12 640	15 920	20 288
75 and over	2 945	3 497	4 551	5 962	8 288	8 957
Not specified	63	21	154	100	16	359
All ages	472 261	557 301	647 825	771 761	861 635	938 280

APPENDIX TABLE 6 *(continued)*

APPENDIX TABLE 6 *(continued)*

AGE IN YEARS	CENSUS DATE					
	Nov. 10, 1899	April 15, 1910	Jan. 1, 1920	April 1, 1930	Dec. 1, 1935	April 1, 1940
			Females			
Under 1	12 940[1]	19 685[1]	21 332[1]	21 781[1]	26 442[2]	29 696
1-4	60 689[1]	71 291[1]	78 025[1]	90 642[1]	95 190[2]	108 455
5-9	70 626	74 651	95 981	110 490	118 301	123 861
10-14	59 241	69 471	82 352	97 962	111 104	112 601
15-19	50 229	60 401	66 065	98 243	94 968	106 689
20-24	46 811	55 016	66 417	74 875	104 524	103 862
25-29	44 796	48 377	51 915	52 261	64 870	75 745
30-34	32 952	35 091	40 465	47 989	45 191	50 584
35-44	45 372	57 810	68 927	81 684	90 847	92 842
45-54	29 690	34 670	41 651	48 676	54 635	59 168
55-64	16 958	19 689	21 989	26 625	29 527	33 023
65-74	6 661	9 461	10 565	13 188	16 064	21 617
75 and over	3 973	5 065	6 157	7 614	10 233	12 244
Not specified	44	33	143	122	3	588
All ages	480 982	560 711	651 984	772 152	861 899	930 975

[1] 16th Census of the United States, 1940. Puerto Rico Population—Bulletin No. 2, Characteristics of the Population, page 10. U. S. Department of Commerce, Bureau of the Census. 1943.

[2] Census of Puerto Rico, 1935. Population and Agriculture, page 23. Puerto Rico Reconstruction Administration, San Juan, Puerto Rico. U. S. Government Printing Office, *Washington, D. C.*, 1938.

APPENDIX TABLE 7

Annual births and average infant mortality rate in Puerto Rico: 1909-11, 1919-21, and 1929-31[1]

BIRTHS							
Year	Both Sexes	Year	Both Sexes	Year	Male	Female	Both Sexes
1909	37 444	1919	46 285				
1910	37 706	1920	50 416	1929-30[2]	26 889	25 509	52 398
1911	39 106	1921	51 190	1931	33 545	32 155	65 700[3]
Total	114 256	Total	147 891	Total	60 434	57 664	118 098
Annual average	38 085	Annual average	49 297	Annual average	30 217	28 832	59 049
INFANT MORTALITY RATE[4]							
1909-11	.15 913	1919-21	.15 169	1929-31	.13 936	.12 290	.13 132

[1] From the Reports of the Commissioner of Health of Puerto Rico.

[2] Fiscal year.

[3] Of the 71,210 births registered in 1931, 5510 occurred in previous years. This was due to a proviso in the new law of Birth Registration allowing for late registration in that year. As these late registered births are not distributed by sex, we assumed, in making the corrections, that they had the same sex distribution as the entire group of 71,210.

[4] Infant deaths obtained from Table 2.

APPENDIX TABLE 8

Abridged life table for Puerto Rico (all classes) — 1909 to 1911

Age interval	Population estimated as of July 1, 1910	Average annual deaths 1909-11	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	39 930	6 061	.15 176	159.13	100 000	15 913	88 479	38.44
1-4	145 575	5 711	.03 923	131.58	84 087	11 064	306 109	44.66
5-9	152 145	1 243	.00 817	40.09	73 023	2 927	356 953	47.23
10-14	144 261	725	.00 503	24.86	70 096	1 743	346 521	44.11
15-19	114 051	943	.00 827	40.57	68 353	2 773	335 308	40.17
20-24	108 929	1 376	.01 263	61.35	65 580	4 023	318 527	36.75
25-29	94 252	1 356	.01 439	69.61	61 557	4 285	297 776	33.98
30-34	70 581	1 083	.01 534	74.05	57 272	4 241	276 467	31.32
35-44	117 092	1 807	.01 543	144.61	53 031	7 669	497 019	28.61
45-54	70 963	1 483	.02 090	191.43	45 362	8 684	415 502	22.50
55-64	38 095	1 280	.03 360	291.79	36 678	10 702	318 512	16.49
65-74	17 290	1 106	.06 397	489.54	25 976	12 716	198 781	11.03
75 and over	8 607	1 302	.15 127	1000.00	13 260	13 260	87 658	6.61

APPENDIX TABLE 9

Abridged life table for Puerto Rico (all classes) — 1919 to 1921

Age interval	Population estimated as of July 1, 1920	Average annual deaths 1919-21	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	1000 ${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	43 225	7 478	.17 300	151.69	100 000	15 169	89 018	38.46
1-4	158 304	5 719	.03 613	122.66	84 831	10 405	310 893	44.28
5-9	196 535	1 511	.00 769	37.78	74 426	2 811	364 292	46.30
10-14	169 574	822	.00 485	23.98	71 615	1 717	354 021	43.03
15-19	129 159	1 180	.00 914	44.75	69 898	3 128	342 232	39.02
20-24	129 542	1 843	.01 423	68.86	66 770	4 598	323 120	35.72
25-29	96 234	1 576	.01 638	78.88	62 172	4 904	299 389	33.17
30-34	78 817	1 408	.01 786	85.72	57 268	4 909	274 860	30.78
35-44	139 820	2 345	.01 677	156.29	52 359	8 183	487 955	28.41
45-54	92 445	1 933	.02 091	191.52	44 176	8 460	404 591	22.63
55-64	46 481	1 645	.03 539	305.05	35 716	10 895	307 855	16.66
65-74	20 396	1 330	.06 521	496.47	24 821	12 323	188 974	11.58
75 and over	10 847	1 378	.12 704	1000.00	12 498	12 498	98 378	7.87

APPENDIX TABLE 10a

75 and over	10 847	1 378	.12 704	1000.00	12 498	12 498	98 378	7.87

APPENDIX TABLE 10a

Abridged life table for Puerto Rico (males), fiscal year July 1, 1929 to June 30, 1930, calendar year 1931

Age interval	Population estimated as of Oct. 1, 1930	Average annual deaths 1929-30, 1931	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	22 651	4 211	.18 591	139.36	100 000	13 936	89 910	40.76
1-4	92 806	3 029	.03 264	112.34	86 064	9 668	317 833	46.31
5-9	114 245	868	.00 760	37.34	76 396	2 853	374 032	48.01
10-14	102 031	384	.00 376	18.64	73 543	1 371	364 628	44.79
15-19	88 485	549	.00 620	30.56	72 172	2 206	355 806	40.59
20-24	75 861	926	.01 221	59.36	69 966	4 153	340 131	36.94
25-29	48 756	646	.01 325	64.27	65 813	4 230	319 245	33.94
30-34	46 985	578	.01 230	59.79	61 583	3 682	299 350	31.08
35-44	83 772	1 180	.01 408	132.71	57 901	7 684	545 739	27.89
45-54	55 104	1 213	.02 201	200.67	50 217	10 077	457 837	21.29
55-64	30 144	1 130	.03 749	320.32	40 140	12 858	342 971	15.23
65-74	13 022	984	.07 556	551.24	27 282	15 039	199 034	9.84
75 and over	6 112	1 080	.17 670	1000.00	12 243	12 243	69 287	5.66

APPENDIX TABLE 10b

Abridged life table for Puerto Rico (females), fiscal year July 1, 1929 to June 30, 1930, calendar year 1931

Age interval	Population estimated as of Oct. 1, 1930	Average annual deaths 1929-30, 1931	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	22 177	3 544	.15 980	122.90	100 000	12 290	91 102	42.19
1-4	91 533	3 002	.03 280	112.82	87 710	9 895	323 730	47.07
5-9	111 159	796	.00 716	35.22	77 815	2 740	381 443	48.89
10-14	98 694	330	.00 334	16.57	75 075	1 244	372 455	45.59
15-19	98 665	705	.00 715	35.17	73 831	2 596	363 077	41.32
20-24	76 324	959	.01 256	61.01	71 235	4 346	346 019	37.73
25-29	53 435	786	.01 471	71.11	66 889	4 756	323 317	35.00
30-34	48 119	720	.01 496	72.28	62 133	4 491	300 200	32.48
35-44	82 242	1 198	.01 457	137.04	57 642	7 899	542 141	29.80
45-54	49 201	900	.01 829	169.37	49 743	8 425	460 634	23.64
55-64	26 945	787	.02 921	258.38	41 318	10 676	365 491	17.31
65-74	13 609	762	.05 599	442.88	30 642	13 571	242 382	11.41
75 and over	7 845	1 248	.15 908	1000.00	17 071	17 071	107 311	6.29

APPENDIX TABLE 10c

75 and over	7 845	1 248	.15 908	1000.00	17 071	17 071	107 311	6.29

APPENDIX TABLE 10c

Abridged life table for Puerto Rico (both sexes), fiscal year July 1, 1929 to June 30, 1930, calendar year 1931

Age interval	Population estimated as of Oct. 1, 1930	Average annual deaths 1929-30, 1931	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	44 828	7 755	.17 300	131.32	100 000	13 132	90 492	41.41
1-4	184 339	6 031	.03 272	112.58	86 868	9 779	320 713	46.63
5-9	225 404	1 664	.00 738	36.28	77 089	2 797	377 654	48.38
10-14	200 725	714	.00 356	17.65	74 292	1 311	368 258	45.12
15-19	187 150	1 254	.00 670	32.99	72 981	2 407	359 254	40.89
20-24	152 185	1 885	.01 239	60.21	70 574	4 249	342 938	37.19
25-29	102 191	1 432	.01 401	67.84	66 325	4 499	321 128	34.40
30-34	95 104	1 298	.01 365	66.15	61 826	4 089	299 560	31.71
35-44	166 014	2 378	.01 432	134.83	57 737	7 785	543 645	28.77
45-54	104 305	2 113	.02 026	186.07	49 952	9 294	458 736	22.37
55-64	57 089	1 917	.03 358	291.65	40 658	11 858	353 127	16.20
65-74	26 631	1 746	.06 556	498.41	28 800	14 354	218 944	10.61
75 and over	13 957	2 328	.16 680	1000.00	14 446	14 446	86 607	6.00

APPENDIX TABLE 11a

Abridged life table for Puerto Rico (males) — 1934 to 1936

Age interval	Population estimated as of July 1, 1935	Average annual deaths 1934-36	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	1000 ${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	26 648	4 334	.16 264	131.14	100 000	13 114	90 505	43.12
1-4	97 339	3 096	.03 181	109.84	86 886	9 544	321 438	48.58
5-9	120 291	775	.00 644	31.73	77 342	2 454	379 867	50.42
10-14	122 747	354	.00 314	15.59	74 888	1 167	371 656	47.00
15-19	88 059	436	.00 495	24.47	73 721	1 804	364 444	42.71
20-24	98 588	1 030	.01 045	51.01	71 917	3 668	351 005	38.71
25-29	59 510	662	.01 112	54.20	68 249	3 699	332 644	35.65
30-34	43 812	504	.01 150	56.00	64 550	3 615	314 348	32.54
35-44	89 930	1 188	.01 321	124.96	60 935	7 615	576 457	29.31
45-54	61 242	1 225	.02 000	183.89	53 320	9 805	490 250	22.68
55-64	32 834	1 130	.03 442	297.89	43 515	12 963	376 612	16.53
65-74	15 671	1 030	.06 573	499.35	30 552	12 256	232 101	11.22
75 and over	8 111	1 122	.13 833	1000.00	15 296	15 296	110 576	7.23

APPENDIX TABLE 11b

65-74	15 071	1 030	.06 373	499.99	13 [illegible]	[illegible]	[illegible]	[illegible]
75 and over	8 111	1 122	.13 833	1000.00	15 296	15 296	110 576	7.23

APPENDIX TABLE 11b

Abridged life table for Puerto Rico (females) — 1934 to 1936

Age interval	Population estimated as of July 1, 1935	Average annual deaths 1934-36	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	1000 ${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	26 088	3 656	.14 014	115.61	100 000	11 561	91 630	45.11
1-4	94 844	2 993	.03 156	109.08	88 439	9 647	327 311	49.98
5-9	117 707	729	.00 619	30.51	78 792	2 404	387 259	51.94
10-14	110 105	309	.00 281	13.96	76 388	1 066	379 359	48.50
15-19	95 217	579	.00 608	29.98	75 322	2 258	371 382	44.16
20-24	102 271	1 030	.01 007	49.20	73 064	3 595	357 001	40.44
25-29	63 912	768	.01 202	58.47	69 469	4 062	337 937	37.39
30-34	45 404	594	.01 308	63.47	65 407	4 151	317 355	34.55
35-44	90 151	1 183	.01 312	124.16	61 256	7 606	579 726	31.71
45-54	54 182	865	.01 596	149.25	53 650	8 007	501 692	25.40
55-64	29 306	724	.02 470	222.66	45 643	10 163	411 457	18.86
65-74	15 845	800	.05 049	408.61	35 480	14 498	287 146	12.66
75 and over	10 034	1 298	.12 936	1000.00	20 982	20 982	162 198	7.73

APPENDIX TABLE 11c

Abridged life table for Puerto Rico (both sexes)—1934 to 1936

Age interval	Population estimated as of July 1, 1935	Average annual deaths 1934-36	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	52 736	7 990	.15 150	123.55	100 000	12 355	91 055	44.03
1-4	192 183	6 089	.03 168	109.45	87 645	9 592	324 315	49.20
5-9	237 998	1 504	.00 632	31.14	78 053	2 431	383 487	51.09
10-14	222 852	663	.00 298	14.80	75 622	1 119	375 503	47.66
15-19	183 276	1 015	.00 554	27.35	74 503	2 037	367 690	43.34
20-24	200 859	2 060	.01 026	50.10	72 466	3 631	353 899	39.48
25-29	123 422	1 430	.01 159	56.43	68 835	3 884	335 116	36.42
30-34	89 216	1 098	.01 231	59.83	64 951	3 886	315 678	33.44
35-44	180 081	2 371	.01 317	124.61	61 065	7 609	577 752	30.40
45-54	115 424	2 090	.01 811	167.83	53 456	8 972	495 417	23.92
55-64	62 140	1 854	.02 984	263.26	44 484	11 711	392 460	17.61
65-74	31 516	1 830	.05 806	455.33	32 773	14 922	257 010	11.93
75 and over	18 145	2 420	.13 337	1000.00	17 851	17 851	133 846	7.50

APPENDIX TABLE 12a

65-74	31 516	1 830	.05 806	455.33	32 773	14 922	257 616	11.93
75 and over	18 145	2 420	.13 337	1000.00	17 851	17 851	133 846	7.50

APPENDIX TABLE 12a

Abridged life table for Puerto Rico (males) — 1939 to 1941

Age interval	Population estimated as of July 1, 1940	Average annual deaths 1939-41	Average death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	1000 ${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	30 441	4 611	.15 147	123.53	100 000	12 352	91 057	45.12
1-4	112 551	3 387	.03 009	104.61	87 648	9 169	325 504	50.44
5-9	128 146	712	.00 556	27.45	78 479	2 154	386 383	52.19
10-14	114 823	311	.00 271	13.46	76 325	1 028	379 336	48.60
15-19	99 748	407	.00 408	20.21	75 297	1 522	373 039	44.23
20-24	103 161	855	.00 829	40.67	73 775	3 000	361 882	40.08
25-29	72 879	721	.00 989	48.34	70 775	3 421	345 905	36.67
30-34	52 144	553	.01 060	51.72	67 354	3 484	328 679	33.40
35-44	94 543	1 180	.01 248	118.51	63 870	7 569	606 490	30.07
45-54	67 132	1 236	.01 841	170.39	56 301	9 593	521 076	23.34
55-65	36 983	1 167	.03 156	276.43	46 708	12 911	409 094	16.98
65-74	20 478	1 231	.06 011	467.41	33 797	15 797	262 802	11.36
75 and over	9 032	1 341	.14 847	1000.00	18 000	18 000	121 237	6.74

APPENDIX TABLE 12b

Abridged life table for Puerto Rico (females) — 1939 to 1941

Age interval	Population estimated as of July 1, 1940	Average annual deaths 1939-41	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	1000 ${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	29 893	3 819	.12 776	106.74	100 000	10 674	92 272	46.92
1-4	108 899	3 382	.03 106	107.57	89 326	9 609	330 935	51.50
5-9	124 194	676	.00 544	26.86	79 717	2 141	392 613	53.55
10-14	112 965	313	.00 277	13.76	77 576	1 067	385 198	49.97
15-19	106 900	547	.00 512	25.30	76 509	1 936	378 125	45.63
20-24	104 584	919	.00 879	43.07	74 573	3 212	365 415	41.75
25-29	76 330	815	.01 068	52.11	71 361	3 718	348 127	38.50
30-34	50 649	585	.01 155	56.24	67 643	3 804	329 351	35.48
35-44	93 119	1 119	.01 202	114.28	63 839	7 296	606 988	32.43
45-54	59 429	920	.01 548	145.05	56 543	8 201	529 780	25.88
55-64	33 182	790	.02 381	215.44	48 342	10 415	437 421	19.31
65-74	21 827	993	.04 549	375.90	37 927	14 257	313 410	13.08
75 and over	12 359	1 601	.12 954	1000.00	23 670	23 670	182 723	7.72

APPENDIX TABLE 12c

75 and over	12 359	1 601	.12 954	1000.00	23 670	23 670	182 723	7.72

APPENDIX TABLE 12c

Abridged life table for Puerto Rico (both sexes)—1939 to 1941

Age interval	Population estimated as of July 1, 1940	Average annual deaths 1939-41	Average annual death rate per person	Chances per 1000 of a person age x dying within interval x to $x+n$	Number surviving to exact age x out of 100,000 born alive	Number dying in interval x to $x+n$	Life table population in interval x to $x+n$	Average years of life remaining to survivors at age x
x to $x+n$			${}_nm_x$	$1000\ {}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	$\mathring{e}_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Under 1	60 334	8 430	.13 972	115.32	100 000	11 532	91 651	45.96
1-4	221 450	6 769	.03 057	106.08	88 468	9 384	328 158	50.92
5-9	252 340	1 388	.00 550	27.15	79 084	2 147	389 429	52.81
10-14	227 788	624	.00 274	13.61	76 937	1 047	382 117	49.22
15-19	206 647	954	.00 462	22.85	75 890	1 734	375 325	44.86
20-24	207 745	1 774	.00 854	41.87	74 156	3 105	363 583	40.85
24-29	149 209	1 536	.01 029	50.25	71 051	3 570	346 939	37.52
30-34	102 793	1 138	,01 107	53.96	67 481	3 641	328 907	34.36
35-44	187 663	2 299	.01 225	116.35	63 840	7 428	606 367	31.17
45-54	126 561	2 156	.01 704	158.63	56 412	8 949	525 176	24.53
55-64	70 165	1 957	.02 789	248.08	47 463	11 774	422 158	18.09
65-74	42 305	2 224	.05 257	421.78	35 689	15 052	286 323	12.23
75 and over	21 391	2 942	.13 753	1000.00	20 636	20 636	150 047	7.27

THE USE OF ICONOMETROGRAPHY[1] IN GRAPHIC EXPOSITION

I. TOPOGRAPHY AND COMPOSITION OF THE HUMAN BODY

BY HARRY A. WILMER[2] AND RICHARD E. SCAMMON

The Department of Pathology, Johns Hopkins University, Baltimore, Maryland, and the Department of Anatomy and the Graduate School, University of Minnesota, Minneapolis.

THE variety of graphic methods now available to us has quite revolutionized methods of presenting both popular and scientific material. We have had until recently two commonly accepted methods of conveying our thoughts to others. These are the verbal and the numerical or tabular techniques. But now there are four: the verbal, the numerical or tabular, the so-called graphic, and the analytic. And the third has been developed to such a degree that it has become one of the principal tools of much medical exposition.

THE GRAPHIC METHOD

This does not mean that beautiful and painstaking drawings of material in anatomy were not published long ago. In fact, the hundred years following the middle of the eighteenth century may be called the age of atlases, for it was during this time that the atlases of Hunter (1751), Velpeau (1833), Bonamy, Broca and Beau (1844-1866), Coste (1847-1858), Froriep (1850), Pirogoff (1852-1859), and at least a dozen others, were published. They have rarely been equalled since.

This great period of anatomic illustration was carried on, although at a somewhat decreased rate, by Hyrtl (1873), Braune (1884), Todt (1896-1900), Sir William MacEwen (1893), Johnson Symington

[1] *Iconometrography.* The word comes from the Greek roots *εἰκών* a picture, or more particularly, a conventional image; *μετρέω*, to measure; and *γράφω*, to draw. While the word *iconography* has been in existence for many years, it has become obsolete in its original sense, and therefore the word *iconometrography* is proposed to define more accurately this type of graphic exposition.

[2] National Research Council Fellow in the Medical Sciences.

(1887), and Rudinger (1877-1879). This latter series of illustrative works changed distinctly in character. The plates became less decorative and more descriptive, while still preserving or increasing their standards of accuracy. Since the beginning of this century this change has become more and more noticeable. A number of outstanding illustrative works have appeared in this period, that by Sobotta (1904), Spalteholtz (1896), and the outstanding American work of Eycleshymer and Schoemaker (1911), those of Sir Victor Horsley on the topography of the growing brain and skull (in the *Cunningham Memoirs,* the Royal Irish Academy, 1892), that of Gustav Retzius on the macroscopic anatomy of the brain (1896) and on the development of the external body form of the fetus (1904), Rasmussen's illustrative study of the fiber tracks of the brain (1932), Bach and Seefelder's work on the eye (1911-1914), and Kollmann's two-volume illustrative work on human embryology (1907). The numerous "Contributions to Embryology" published by the Carnegie Institution of Washington, have definitely tended to assume atlas form. And finally, the great development of this phase of illustration that has been made possible through roentgenography (particularly teleoroentgenography) has tended to specialize the work still more.

But the presentation of material by means of illustration of carefully chosen specimens or individuals is only one form in modern graphic methods. Not many years ago the possibilities of exposition by the graphic methods seemed rather small in the medical field. Statisticians like Pearl (1930) and King (1916) presented short summaries of them in their textbooks and a committee of the American Statistical Association in 1915 laid down some rather pedestrian rules for their use. The recent developments in the field have made these classifications obsolescent. While any attempt to classify these procedures that are in flux at the present time must be tentative at best, the following schema seems logical:

The graphic method in general:

A. The simple illustration
B. The iconometrographic method
C. The coordinate graphic method
D. The analytic graphic method

The briefest descriptions will be given of *A, C,* and *D,* but *B,* which forms the subject of this paper, will be treated in more detail.

A. The simple illustration

This procedure needs little elaboration in the light of our earlier remarks. However it is undergoing distinct changes in modern hands. A few words of its history may be worth attention.

It is generally assumed that the production of scientific and medical publications was an integral part of the rise of printing in the latter fifteenth and early sixteenth century. But investigators like Frank (1920), Thompson (1925) and Crummer (1927) have shown that this is not the entire truth. A more factual examination of the evidence indicates that the medical and scientific man of this period was quite uncertain of the medium in which his work would be produced. The earlier wood-blocks from which he had hoped to make his material lifelike and correct were miserable failures. The work was generally coarse and ill-done, and above all it was strictly conventional. There had existed during the Middle Ages a number of series of illustrations on anatomical, obstetrical and surgical subjects generally inscribed on parchment in established sets of fives. There is every reason for believing that these schemata or graphic mnemonics had been handed down from Hellenic times, becoming a little more unnatural and fixed with each generation. It is a curious thing that the medieval artist, who could draw or carve flowers or insects with a skill rivaling that of the Dutch naturalistic painters, fell so completely under the sway of conventional form. Early printed books show these same series of five, which extend from Scandinavia to India, and are almost identical over this great area, with most of the errors and absurdities of an earlier period. At the same time that the first books in science were being printed, paintings were being used and manikins in ivory carved to represent the same objects, and the last two are distinctly better done. We have no direct evidence on the subject, but probably pictorial and plastic representations were at least equal in effect, if not in number, to printed illustrations in spreading newer knowledge. This contest continued for at least two generations and cropped out occasionally even in the seventeenth century.

In the meantime a number of techniques, including the copper plate, had been invented and a new group of craftsmen took the place of the old. Really excellent plates were produced, often in series. But the rights of authorship lay with the transitory owner rather than with the scientist who performed the experiments, made the observations and

often designed the plates. This absurd condition accounts for much of the difficulty of bibliography and the curious context of these early medical and scientific books. Titles were confused, transferred, and often changed outright, while the printed context of the pages often had little to do with the plates that accompanied them. This condition continued into the eighteenth century, when the plates gradually became too expensive for the accompanying text. A divorce of text and illustration occurred.

Both the specialists and medical students were increasing in number and each of these classes demanded more accurate and realistic graphic material. Printing costs and particularly the cost of fine paper had risen to a point where the medical text intended for the mass of the students had passed the reach of their purses. To these conditions we may attribute both the appearance of the great atlases, a part of which have been discussed, and the formation and development of museums that were definitely founded for poor students who could not afford these luxuries, as well as for the busy practitioner who hesitated to buy them for short "refresher" courses.

The text of the standard anatomical works, for example, improved enormously. Works like Samuel T. Soemmerring's *Vom Baue des menschlichen Körpers,* published at Frankfurt am Main in 1796-1800, and Ernst Weber's edition of Friedrich Hildbrandt's *Handbuch der Anatomie des Menschen,* which was distinctly larger, were typical of the period. They are rich in accurate information, well arranged, and provided with excellent notes and bibliographies. Neither contained a single illustration, but both quote references to atlases that would have met this need. Perhaps the most outstanding book of this kind is Hyrtl's *Handbuch der Anatomie,* which was immensely popular, going through twenty editions between 1846 to 1889, with but a single illustration—a rather miserable diagram of the pulmonary and aortic valves—occupying perhaps a square inch of space.

It is not surprising that difficulties arose in connection with the fine atlases that accompanied the early texts. Perhaps the most important was the rather acrimonious discussion between Bernhard Siegfried Albinus and Pieter (or Petrus) Camper in the middle of the eighteenth century. Both Albinus and Camper were magnificent artists and anatomists and the subject at issue was so important that the controversy cannot be neglected, even though it was conducted in Latin nearly two hundred years ago. Albinus published in 1754 to

1768 two volumes having the title *Annotationes Academicae,* Libri I-VIII. They contained a set of thirty-five beautiful copper plates on a variety of subjects in anatomy, physiology, surgery and the like. In Liber VIII of the second volume he explained his method of illustration in detail. The average or, as we would call it today, the median specimen of the series of specimens of a given object was picked.

This procedure may be regarded as the beginning of both modern anatomical illustration and also iconography (or more correctly iconometrography). He stated his reasons for adopting this technique in detail in Liber VIII. A portion of this argument is as follows:

> "To reproduce, not free hand (according to the view), as is customary, but from actual measure: to reproduce what the best in nature displays: to reproduce, not as the demonstrators of anatomy generally do, by merely placing before the eyes of the artist what they have uncovered, but by collecting [data] from one body after another, and making a composite according to rule so that the actual truth will be displayed, etc. I am of this opinion, that what Nature, the arch workman, which is generally the source of everything, has fashioned must be sifted with care and judgment, and that in the endless variety of Nature the best elements must be selected. Then it does not suffice, though this to be sure, is something, to search the body and reveal its composition like a carpenter dismantling a house with care, but just as the architect knows the structure through and through; in the same way we must thoroughly acquaint ourselves with the composition of the body."

He also devised another process that is equally a part of modern morphological illustration and the "new" scheme of iconometrography. This was to draw all specimens after careful measuring through a double grid or network. The two grids were placed in alignment so far apart that a teleographic or orthoscopic effect was produced. Of course, the size of the meshes in the grids had to be adjusted for the distance from the object. A portion of Albinus' description of the process is:

> "And not a single picture was drawn free hand. All have been measured, brought down to scale, either from an indeterminate distance, as the architects do, a method which has been followed in most cases; or from a distance of forty feet through diopters which corresponds to an indeterminate distance in such cases, as for example, the pictures of the skeletons, upon which finally, as upon a ground plan, the muscles have been drawn in. Where the skeletons were not large enough the muscles have been measured from an indeterminate distance, and finally reproduced, somewhat [fore]shortened

as the distance from the center required. The tiny bones of the ear the artist measured with a very small and perfect compass, the points of which were particularly sharp. I have chosen, in so far as I was able, a position where the matter of [fore]shortening could be reduced to a minimum, in order that, since the [fore]shortening could not be altogether avoided, I might meet the needs of the inexperienced, who would, I knew, be many."

Camper took a different position in a bitter criticism of Albinus in 1767. He adopted the system of perspective, generally in use at the time. That he should do so is not surprising, for he had previously written on artistic and architectural subjects, since there was a great vogue for putting up public buildings at that time. It is probable that Camper won so far as immediate and popular opinion was concerned. His work was translated in Dutch, French, and German, and must have been quite popular if one can judge by the number of editions sold. But with the greater cultivation and precision of the morphological sciences, Albinus' methods have come more into use and are distinctly those of choice from the standpoint of simple illustration at the present time.

The fusion of text and illustration that we see in practically all books and papers in the medical sciences today is, in fact, rather recent when measured in terms of the time required for the development of scientific techniques. It began to be evident about a hundred years ago as the technique of the woodcut was greatly improved and engravings or lithographs were no longer essential. It grew with the application of photography to the woodcut process, but its real development occurred in the late 1860's with the development of the zinc-line figure, and of the halftone a little later. As these processes of graphic reproduction improved and a new school of scientific artists developed to prepare original drawings for them, they became more and more a part of the document so that today we are surprised if we find an unillustrated scientific work. But, as the preceding account indicated, this is the outcome of a long and curious history that shows many breaks and discontinuities.

Since this paper is primarily an exposition of iconometrography, it remains to write a brief sumary of *C*, the coordinate graphic method, and *D*, the analytic graphic method before taking up this method.

C. The coordinate graphic method

The term coordinate graphics is a broad one, but it seems to be the only expression that covers a very large class of graphic descriptions

of the most variable form and purpose. The method may be used for representing a variety of properties of measurable or countable things. These may be central tendencies, variabilities (however established), ratios, proportions, trends, analytic expressions of various degrees of precision and measures of that precision, derivatives of all kinds, and a number of other properties.

The following three generalizations may be made regarding this graphic form:

(1) Only one condition is requisite: that the points or lines in such a construction be placed in proper position to a preestablished network of coordinates. The form of this network is not of the slightest importance, theoretically. Its value depends on its usefulness in the presentation of the subject at hand. The fact that no coordinate appears in some graphic presentations has no significance, provided a coordinate system was used in their original construction.

(2) Coordinate systems may be as varied as desired. Most of us are familiar with the typical rectangular or square Cartesian coordinate system and the circular or polar coordinate system. But there are a variety of non-Cartesian coordinate systems of great value. The double- and arith-logarithmic grids and the probability form are fairly well known. But the coordinate systems may be built to practically any mathematical function. Their use in biology dates to the work of Guiseppe Olivi in 1792, but they remained unused until the study of Bujard (1914), who worked on the changing form of the human embryo, and the noteworthy paper on *Morphology and Mathematics* of Sir D'Arcy Thompson (1915). The latter author expanded his work in a book appearing the following year under the title *Growth and Form*.

(3) The use of coordinate graphics is much older than is commonly thought. One quite elaborate coordinate graph of the tenth century has been discovered and adequately deciphered by Funkhouser (1936). The same author, in his monograph of 1937, has traced the use of the graphic form to ancient Egyptian times. Thus the tradition that this form of graphic description was devised by Descartes turns out to be, as many students of the subject have long suspected, pure myth. Non-Cartesian coordinate systems, which are often regarded as quite new, for outlining the form of the human body were used by Albrecht Dürer and appeared extensively in his posthumous volume of 1528 that was prepared for the press by his friend Willibald Pickheimer nearly seventy years before the birth of Descartes.

D. The analytic graphic method

The use of analytic expressions in biology is almost entirely a product of this century, although there is hardly one of them that was not worked out, tested and published at least a generation earlier, by some lone biologist whose work has been forgotten. Properly speaking this method should not be included with graphics at all, for the pure analytic treatment of data does not require the use of this art. In practice, however, the analytic mathematics of the biologist or the physician are applied, and not pure, mathematics, and graphic or mechanical methods are used in their development. This, together with the development of methods, both mechanical and graphic, by which the property of a "progression" or a "curve" can be represented without knowing its "function" or "formula," has made their pictorial presentation increasingly popular.

B. The iconometrographic method

Of these various methods of graphic representation the iconometrographic is perhaps the most powerful and flexible, but it is also the most recent and by far the least known. The primary purpose of this paper is to describe it and to illustrate it by a series of original examples of its application.

Iconometrography is that branch of graphics that represents comparison between two or more bodies or structures, or the changes in one body, by means of figures drawn to some common scale. As a rule it is applied to represent changes in form rather than those in size or structure or composition, but it may be applied to the illustration of differences in these properties as well. The classification of iconometrographs can hardly be precise at the present time for their forms are so flexible and their possibilities are by no means fully explored. The following tentative scheme of classification is suggested for use at the present time.

Iconometrographs based upon:

(1) The representation of the body or its parts at a standard magnification or reduction.

(2) The reconstruction of the body or its parts to a standard and equal dimension.

(3) The reconstruction of the body or its parts to standard and equal areas.

(4) The reconstruction of the body or its parts to standard and equal volumes.

(1) The representation of the body or its parts at a standard magnification or reduction

This simple method consists of drawing two or more figures in their original proportion to each other. Body length or stature is commonly used as a criterion of size.

Simple as it is, this was not attempted until the early part of the eighteenth century. So far as we are aware, Soemmerring was the first investigator to apply it in drawings of a series of fetuses published in 1798. These have been reproduced many times since. A few figures of postnatal development of the body were published by Schadow in 1834, and in 1870 Quetelet published a fairly complete series. These have been added to by Froriep (1880), Fritsch (1900), and others. New series of human embryos represented by this method were published by His (1880), Mall (1894), Retzius (1904), and by many later writers.

Internal anatomical structures, particularly the bones of the skeleton, were represented in this fashion by Cloquet in 1826. They compare the newborn with the adult. Later work of this kind is quite common. It includes that of Welcker (1856), Henke (1881), Stratz (1903 and 1915), Scammon (1925), and others.

(2) The reconstruction of the body or its parts to a standard and equal dimension

This representation of two or more physical bodies drawn to the same dimension regardless of their actual size is a most useful form of iconometrographic treatment. It may be developed in a number of ways, some of which are as follows:

(a) The bodies are brought to an equal total height or length, or any other standard axis, regardless of the actual length of this axis. This method was used in a diagrammatic form by His in 1882 to represent the embryonic development of the digestive tract. (This forms figures 10 to 14, inclusive, page 24, of his work.) But its rigorous application seems to date from the work of Franz Merkel

in the same year on the postnatal growth of the base of the skull. Langer in 1884 showed in a crude form a diagram of the newborn and adult held to the same height, which figure was reproduced by Donaldson in 1895. Later developments of this treatment were made by Stratz (1909 and 1926), Scammon (1921), Dunn (1922), and Scammon and Calkins (1929). Langer also applied the same method to the representation of the newborn and adult skull. Cunningham employed it in 1886 in a memoir on the growth of the spine. Holl (1898) made an excellent study of the facial skeleton with it. Merkel again used the method in a comparison of the newborn and adult pelvis. But so far as we are aware, the method was not used again, except for Minot's (1909) figure (which is a copy of His' earlier one), until 1922 when Dunn applied it. Since that time Scammon has applied it to the pre- and post-natal growth of the spine.

(b) A second and more complex form of this method is the reduction of entire bodies to an equal size of some component part. Thus, for example, we may represent two or more bodies of quite unequal size and form in terms of their arm lengths. It is commonly necessary to have empirical formulae in order to use this method. The procedure is quite new. It was first used by Nanãgas in the University of Minnesota Laboratories of Anatomy in a monograph on the development of the anencephalic fetus in 1925.

Using the empirical formulae for the external dimensions of the body that had been developed by Calkins and Scammon (1925), Nanãgas reconstructed and superimposed images of normal and anencephalic fetuses after he had computed their dimensions and form in eighteen different ways from as many dimensions. It is fair to say that this work gave us an entirely new picture of the anencephalic type of abnormality and an insight into its development that we had not previously possessed.

A second study of this kind was made by Mead (1930) in a very complete study of one simple monster and one double monster. He compared these graphically with normal fetuses, again using the formulae of Calkins and Scammon (1925). He made thirteen reconstructions of the body form of the single monster and twelve of the double one (a Cephalothoracopagus monosymmetros). The latter had particular value for they illustrated a method of comparing a double monster with a normal single individual of the same dimensions and also with two normal individuals. Mead's study illustrates the possibili-

ties of the application of this method of precision to the hitherto entirely descriptive techniques used in human teratology.

(3) The reconstruction of the body or its parts to standard and equal areas

In viewing an object we see it essentially a plane. It seems therefore a reasonable procedure to compare two or more bodies or parts by reducing them to planes of equal areas.

This method has had a curious history. It seems to have been first applied by His in 1882. He made no graphics with the method, but he did calculate the areal growth of the upper and lower extremities and compare each to that of the entire body as seen in lateral view. He made a more extensive table for the growth in area of the head and trunk, and gave his figures in both absolute and relative form. (These computations are to be found in Tabelle III, S. 68, and SS. 70-71 of His' work.) We have found no evidence that this method was employed again until fairly recently. In 1926, H. L. Dunn suggested the principle to Scammon who undertook its development.

The present method of application consists of securing orthoscopic images of the object to be compared, using "bench-marked" or permanent orientation points. These images are then brought to the same area by photography and the new images superimposed by the use of the "bench-marks." A short description of this method was published by Scammon in 1929. In 1933 Peyton described it more fully and illustrated it by a detailed description of the topography of the brain and skull from birth to maturity.

The method has since been applied to the growth of the human lens by Scammon and Hesdorffer (1937) and to the eye by Peyton (1940).

(4) The reconstruction of the body and its parts to standard and equal volumes

This device is essentially in its infancy. In 1926 Stratz made a comparison of the water and dry weight, respectively, of men and women, by bar diagrams, and in another bar diagram showed the relative amount of bone, muscle, fat, viscera and blood in the two sexes. However, this can hardly be regarded as a full application of the method, for the columns are drawn to proportionate height only. One sees their relative area but not their relative volume. In 1936 Scammon and Hes-

dorffer made a study of the growth of the human brain in which the concept of proportionality is preserved, for they represented the organs at different ages as spheres computed with respect to volume, "free" surface area, and "total" surface area. Two extended examples of this type of histogram were reported by Wilmer in 1940.

The use of iconometrographs in determining variability

Another use of iconometrography quite different both in principle and in method is the picturing of objects that cannot be measured with accuracy but which can be placed in series. The pictures are done in simple form and always at a constant proportion to the objects drawn. An example may explain this process. One is given 101 roentgenograms of the right hand of 101 boys six years of age. These show a considerable degree of variability. But measurement of such complex objects is difficult and inaccurate and the figures obtained give the reader no sense of the variability encountered. It is possible, however, to arrange such objects in series extending from the least developed at one end to the most developed at the other. This arrangement is made and checked by other observers. One then selects the middle object in the series, i. e., the roentgenogram in this instance we are considering lies between fifty less-developed and fifty more-developed hands. This is traced and drawn. If one wishes to show the median and the range in the series one would take the first, fifty-first, and the one hundred and first and draw them in order. Subdivisions of the series may be carried to any degree the investigator wishes. This method then gives us a graphic picture of central tendency and variability. This device was developed in 1928 by Scammon who published a short note on its use in connection with the study of the fontanells. Sawtell applied it to her study of the ossification of the bones of the foot (1933). A very successful application of this method to the growth of ossification centers has been published by Vogt and Vickers (1938).

The present study presents a series of examples of the iconometrographic method, including types 1, 2, and 3 listed in the preceding classification. The linear or dimensional and areal reconstructions are shown in a series of comparisons of the anatomy and external form of the full-term newborn and of the adult.

RECONSTRUCTION OF THE BODY AT EQUAL MAGNIFICATIONS OR REDUCTIONS, EQUAL AXES, AND EQUAL AREAS

Three sets of examples are presented illustrating one phase of the iconometrographic method, based on axial and area criteria. The reconstructions were of comparisons of the major anatomical structures and form of the newborn and adult, respectively. These were made from the following materials:

Newborn

(1) The casts of the voluntary musculature made by Dr. J. C. McKinley (1917).
(2) The skull as determined in the newborn (51 cm. crown-heel length) from carefully oriented roentgenograms taken by Dr. Leo G. Rigler.
(3) A series of approximately 120 roentgenograms of dead full-term and premature infants taken carefully by Dr. C. B. Young.
(4) A cast of the newborn viscera made by Dr. Lee Barry (1923).
(5) A series of orthoscopic reconstructions stored in the Anatomy Laboratories of the University of Minnesota. These have been accumulated over many years and have always been made with an accurate instrument under strict supervision.
(6) A series of reconstructions made by Dr. Angus L. Cameron.
(7) A graphic reconstruction from quite thin (0.5 cm.) sections of the head, neck, and trunk of a full-term newborn (Adkins, 1939).
(8) A series of careful anatomically drawn dissections of the musculature of the full-term newborn after injection with 10 per cent formalin plus 1 per cent chromic acid.

Adult

(9) The material on the adult was more easily obtained. It was drawn mainly from the scaled drawings of the body form by Merkel (1885-1907), Geyer (1878-1902), the well known His model cast, from the actual specimens, and Piersol's *Human Anatomy* (8th edition of 1923).

The method

All specimens were brought together, teleophotographed, measured as scaled for magnification to major diameters and then as to silhouette surface with an Amsler rotating planimeter (eight-inch radius, accurate instrumentally to 0.01 of a square inch). They were then placed in the following combinations: one adult and one newborn each by means of an automatic dark-room reducing glass. The result was thirty graphic reconstructions that were placed side by side on a common scale. (Comment: This type of reconstruction measures

size and form primarily. The reconstructions could have been arranged, as far as theoretic purposes go, to a common crown height. However, the purpose of iconometrography is eminently practical and the arrangement adopted seemed to give the better results.)

From the tracings the reconstructions that are indicated in the following schema were traced on bristol board, inked, labeled and provided with captions. Mr. Lawrence B. Benson's aid in this long task deserves our highest gratitude.

Scheme of the reconstructions made of the newborn and adult in this study

Reconstruction criteria	*View*	*Structures exhibited in outline of body*
Standard reduction	Anterior	Skeleton Musculature, subcutaneous tissue and skin Major visceral mass and central nervous system
Equal axes	Anterior, posterior, and lateral	Same as above
Equal areas	Anterior	Same as above

Description of plates

Plate 1. Reconstruction to a standard reduction of stature (anterior).

Plate 2. Reconstruction to same total height (anterior).

Fig. A. Remarkable differences are evident in these drawings which were not recognizable in Plate 1. The difference is not due to the simple magnification, but due to the relative magnification by the side of an adult of the same height. A difference in the general morphology and form as well as in the individual component parts of the body is noted on bringing the newborn to the same height as the adult. Thus, by increasing the stature of the newborn three-fold, we magnify the differences tremendously when compared to an adult of the same height. The general change in the form of the skeletal mass is apparent as well as the important differences in the skull, trunk, and limbs, respectively. The wide, flaring truncated pyramidal form of the newborn thorax has changed in the adult to an organized thoracic cage, gradually enlarging from above downward to approximately the middle of the

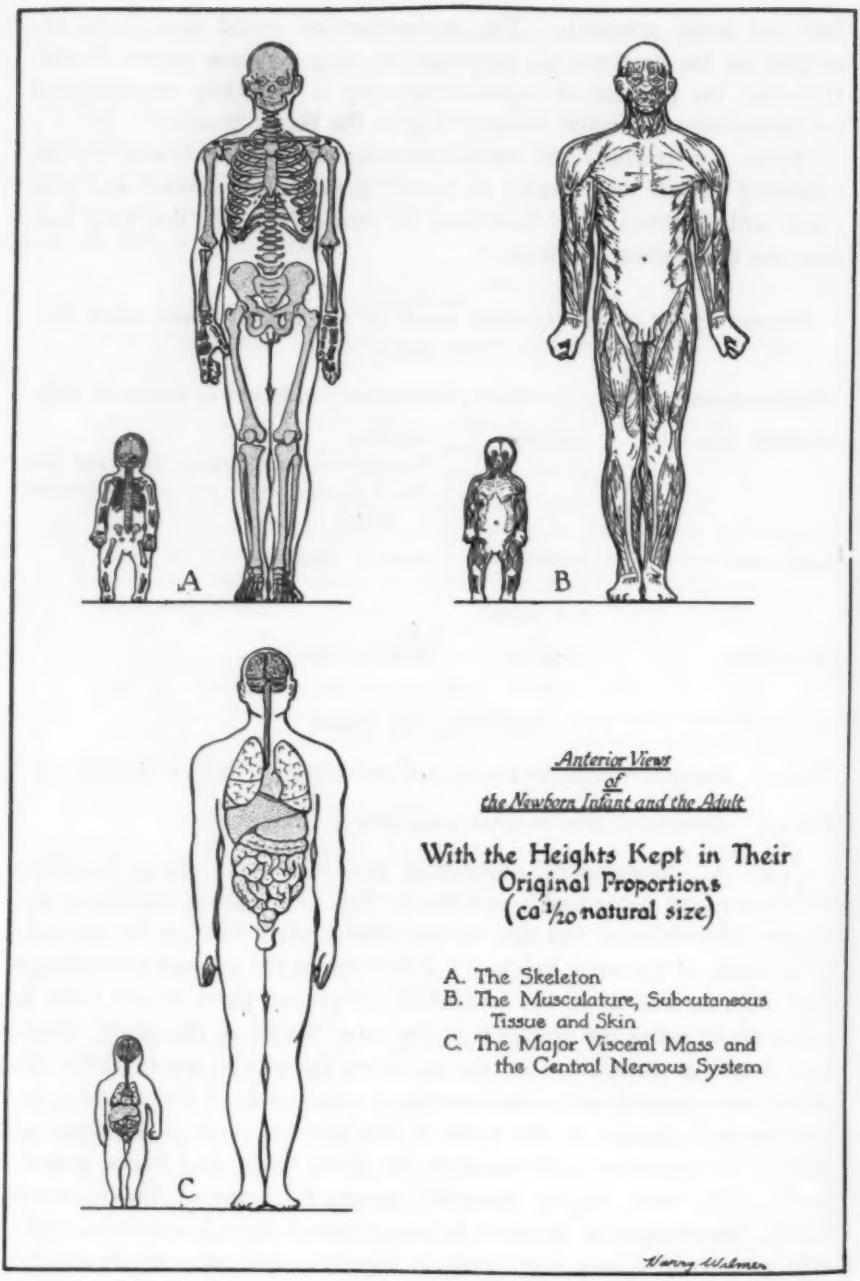

PLATE I

RECONSTRUCTIONS OF NEWBORN INFANT AND ADULT TO ORIGINAL PROPORTIONS; ANTERIOR VIEW

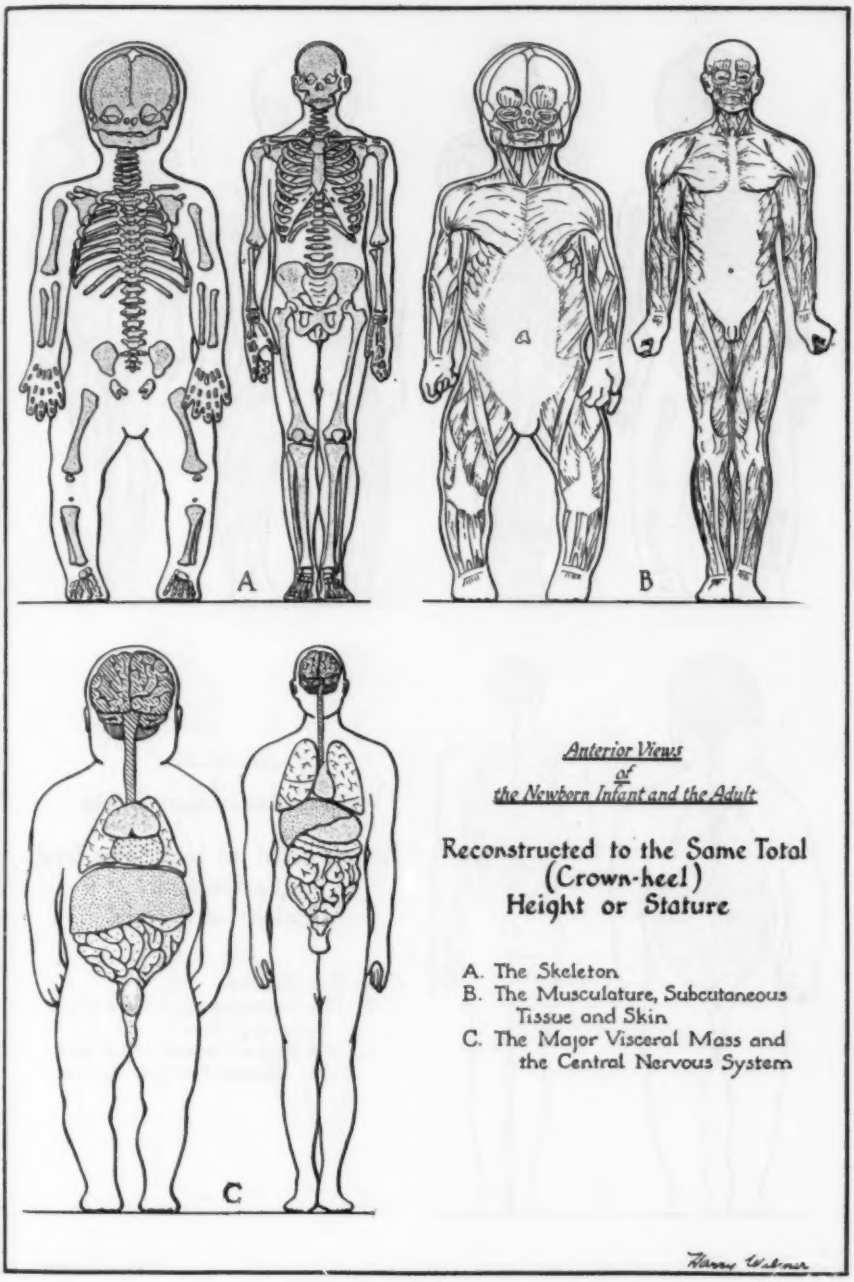

PLATE 2

RECONSTRUCTIONS OF NEWBORN INFANT AND ADULT
TO SAME STATURE; ANTERIOR VIEW

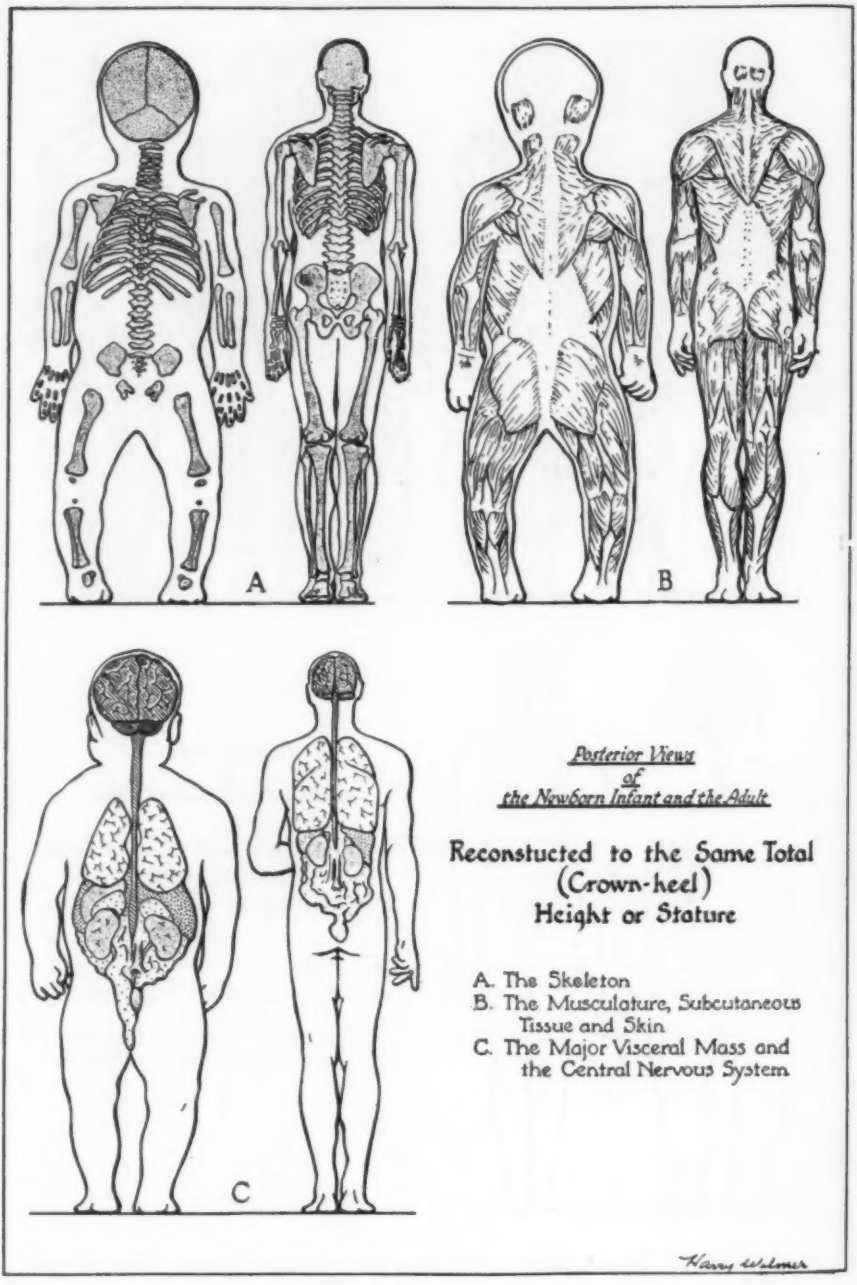

PLATE 3

RECONSTRUCTIONS OF NEWBORN INFANT AND ADULT TO SAME STATURE; POSTERIOR VIEW

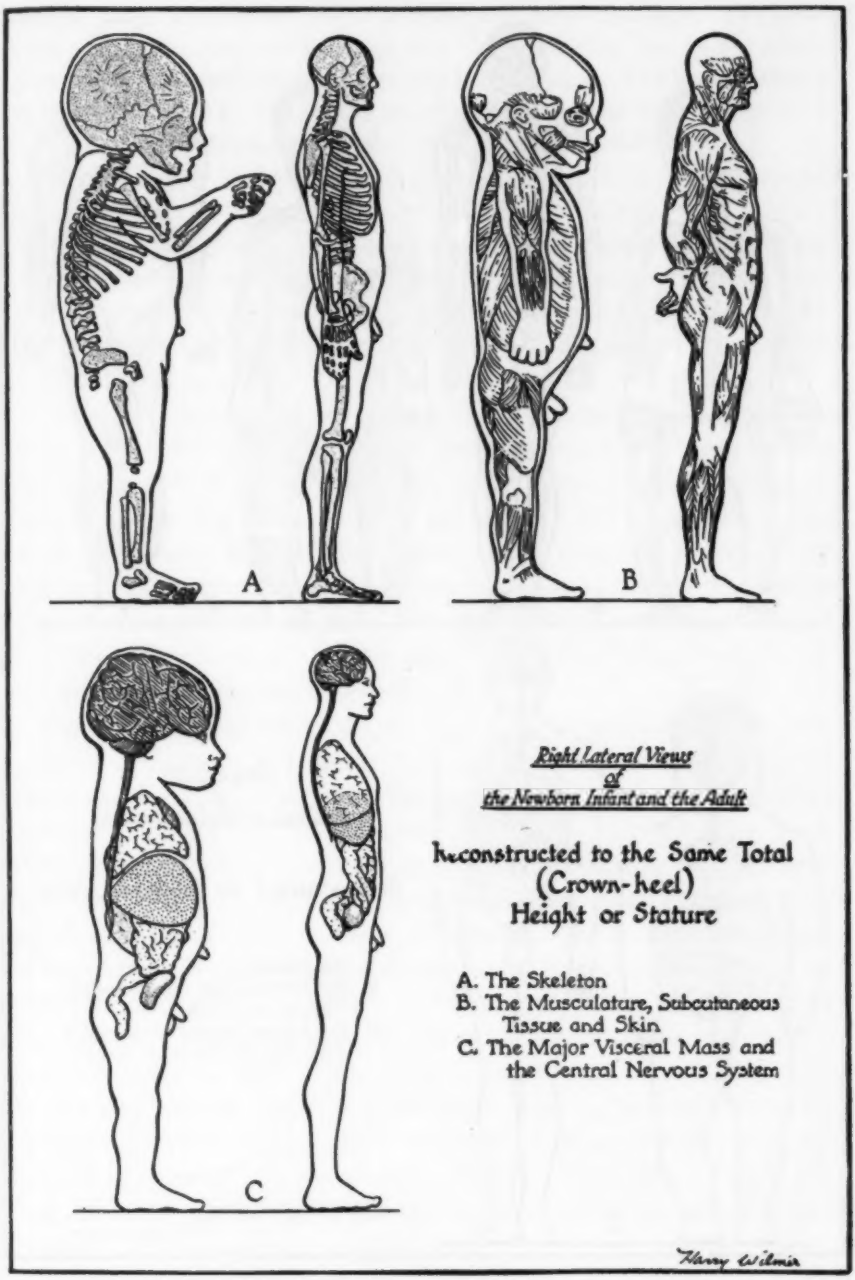

PLATE 4

RECONSTRUCTIONS OF NEWBORN INFANT AND ADULT TO SAME STATURE; RIGHT LATERAL VIEW

This figure has been reproduced from Morris' *Human Anatomy*, 10th edition, page 44, by permission of Blakiston Company.

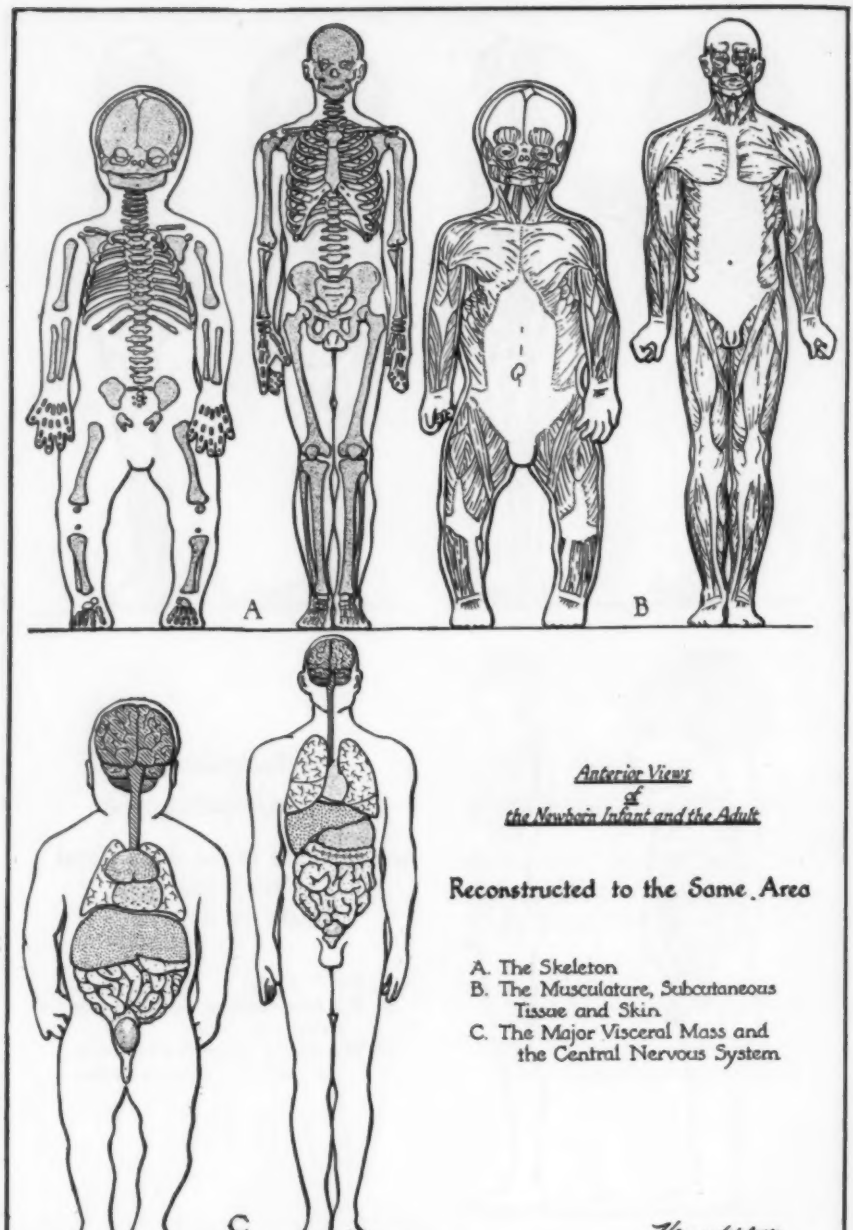

PLATE 5

RECONSTRUCTIONS OF NEWBORN INFANT AND ADULT TO SAME AREA; ANTERIOR VIEW

thorax, from which point down the thorax is almost straight. The newborn skull while presenting a large unit of the skeleton (ca. 25 per cent), is considerably smaller (ca. 10 per cent) in the adult. The great increase in the skeletal structures of the lower extremities can be demonstrated. In the transition from newborn to adult the spinal column seems to rise up carrying with it the arms and pelvis while the legs can be thought of as growing to fill the gap between the pelvis and feet.

The short external neck of the newborn is in distinct contrast to the long cervical portion of the spinal column. This apparent discrepancy is easily explained on the basis of the large area of fat and muscle as seen in Fig. B. The least striking change in any single unit of the skeleton is noted in the arms.

Fig. B. The head of the newborn is larger and broader than the adult. The neck is broader, and a generally magnified image of the adult neck. The trunk is also larger, but of exceedingly different configuration than the adult. It looks not unlike a hen's egg with its appendages attached at their appropriate places. From the anterior view the legs of the newborn represent about the same area as the muscle mass of the adult legs. So aside from the head and neck being changed in form and reduced in size, the rest of the muscle mass seems to be, for the most part, merely remolded.

Fig. C. The most astonishing changes both in morphology and composition are seen in this figure. The entire central nervous system of the newborn infant could be superimposed upon and not exceed the adult abdominal viscera with the exception of the liver. On the other hand, the central nervous system of the adult is not much larger than the newborn bladder and a part of the lower bowel. The thoracic viscera show an absolute change both in form and content. The form is comparable to the changes in the bony thoracic cavity, but there is an increase in the size of the lungs at the relative expense of the heart, and the cost of the thymus. The abdominal visceral mass of the newborn infant is proportionately as large as the entire major visceral mass of the adult. In the newborn the liver and intestinal mass apparently share the abdominal cavity equally, and represent a mass elongated in the transverse diameter. In the adult the liver is greatly diminished in size and sits like a cap on top of the abdominal visceral mass which is now elongated in the perpendicular diameter.

Plate 3. Reconstructed to the same total height (posterior).

Fig. A. The changes in the vertebral column are obvious. The most significant change from the newborn to the adult skeleton with the exception of the changes in the individual components, is the development of the shoulder and pelvic girdles, which make the skeleton a single unit rather than the loosely organized head, trunk, limbs of the newborn. Even in the newborn the visceral mass and the muscle mass are part of a more organized unit, and they seem to "grow up" while the skeleton "grows up and grows together."

Fig. B. One can see the proportionately greater area of fat and subcutaneous tissue of the newborn. It is as if the newborn had put on an "overcoat," before coming into the world, for, indeed, the fetus only a few months before had little subcutaneous fat. The muscle mass of the buttocks of the newborn seems to form a part of the lower leg in form, and is not like that of the adult buttocks which conforms to a much more highly developed pelvic girdle.

Fig. C. The changes in relationship of the central nervous system to the major visceral mass are clearly evident. In the adult the area of the brain is relatively much smaller and the spinal cord shorter. The changes in the relationship of the spinal cord to the viscera is due to the failure of the cord to grow as rapidly as the spinal column. When the visceral mass "grows up" the sides are pulled in and the lungs expanded. From the posterior view the major visceral mass of the adult is somewhat like an elongated oval, while the major visceral mass of the newborn is pear-shaped, bulging at the bottom, and becoming narrower in the thorax. The larger newborn kidneys and suprarenals make up a striking part of the posterior view.

Plate 4. Reconstructed to the same total height (lateral).

Fig. A. From this view the head of the newborn seems even more enormous. The change in the spinal curvature, and the results of that change are readily appreciated. The longitudinal axis of the newborn thorax is directed towards the spinal column below, while the axis of the adult thoracic cage is directed towards the spinal column above, and paralleling the thoracic vertebrae because of the double curvature effect. The ribs of the newborn look as if they belong to the whole trunk, but in the adult they are definitely only a part of the thorax. With

the adult changes in the pelvis, the lower limb becomes a separate unit rather than appearing as a continuation of the trunk of the newborn.

The sternal ossification centers are a typical example taken from the monograph of Vorvanski. The large amount of soft tissue of the neck, the more centrally located cervical vertebrae, and its change in curvature together with the changes in the upper thorax help explain and demonstrate the differences between the newborn and adult neck which are less obvious from external inspection alone. By itself, this drawing more than any of the others shows the basis of the changes not only in morphology and topography of the body, but of the visceral, nervous, and muscular composition as well.

The femoral epiphysis is present in 95 per cent of the mature newborns, and the tibial epiphysis in 77 per cent (Adair and Scammon, 1921).

Fig. B. On the basis of Fig. A the changes in the musculature are explainable. More obvious changes are noted between the newborn and adult musculature when seen from the lateral view than from the anterior or posterior. The thick sagging trunk of the newborn with arms hanging more anterior is changed in the adult to a somewhat reniform trunk, the arms being thrown back. The awkward appearance of the newborn when straightened out is shown, as well as its peculiar short legs which seem to hang from the trunk, and the great area of subcutaneous tissue.

Fig. C. Here again the viscera show remarkable changes in form and relative predominance. The changes in form can be related to the skeletal changes as seen in Fig. A. As the changes in the pelvis and thoracic cavities take place the viscera conform to these newly shaped compartments. What with the relative decrease in size of liver, the disappearance of the thymus, the shorter spinal cord, and the general elevation of the visceral mass, the entire topographic relationships are changed. The entire major visceral mass of the adult could be plotted out and superimposed on the newborn brain with plenty of room to spare, while the adult brain corresponds more closely to one newborn kidney.

Plate 5. Reconstruction to the same silhouette area (anterior).

Many of the differences noted in Plates 2, 3, and 4 are modified by enlarging the newborn to the same area as the adult. (Note: as a matter

of fact, for practical purposes, both figures were drawn to the same total height, and then their silhouette areas determined with the Amsler planimeter and equalized by enlarging the adult. Note that the adult in this series is absolutely taller than in the others. Actually the entire series is relative so that more correctly one might think of the infant being magnified to a height not quite equal to that of the adult).

In this comparative respect, the area reconstructions represent a step between the original proportions and the same total height reconstructions. There is some question as to whether silhouette area may be closely related to morphology and form. Certainly one is just as entitled to employ it as the equally arbitrary crown-heel dimension, and then meditate upon the results. Surface area, or volumetric area in three-dimensional iconometrograms have recently been employed by Scammon.

RÉSUMÉ

1. The position of graphic description in biological and medical literature is outlined and the following provisional classification of its various forms is proposed:

A. The simple illustration
B. The iconometrographic method
C. The coordinate graphic method
D. The analytic graphic method

2. A brief history of the simple illustration, the coordinate graphic method and analytic graphic method is presented. It is pointed out that:

A. Medical publications had a quite different history from other printed works in that graphic and plastic representation formed an important and almost separate method of exposition.
B. The coordinate graphic method is much older than generally assumed. It may be extended beyond its present use. It is governed only by the requirement of a coordinate net and the form used depends only on convenience and usefulness.
C. The analytic graphic method has been in use a relatively short time although it was developed a number of years ago.

3. The iconometrographic method is described in some detail:

A. The representation of the body or its parts at a standard magnification or reduction.
B. The reconstruction of the body or its parts to a standard and equal dimension.

C. The reconstruction of the body or its parts to standard and equal areas.

D. The reconstruction of the body or its parts to standard and equal volumes.

4. This method is illustrated by a series of thirty figures gathered in five plates representing the differences in form and internal structure of the adult and newborn, and the significant points brought out are noted.

BIBLIOGRAPHY

1. ADKINS, C. D. 1939. Topographical anatomy of the neck, thorax, abdomen and pelvis of the newborn. (Ms. of unpublished thesis for the degree of M. S., Univ. Minn.)
2. ALBINUS, B. S. 1754-1768. Annotationes Academicae, Libri I-VIII. *Leidae.*
3. BARRY, L. W. 1923. Model of the viscera *in situ* of a newborn infant. Specimen in the anatomical museum of the Univ. Minn. (Figure of the anterior view published by R. E. Scammon in Abt's *Pediatrics*, vol. 1, p. 316, fig. 121.)
4. CALKINS, L. A., and SCAMMON, R. E. 1925. Empirical formulae for the proportionate growth of the human fetus. *Proc. Soc. Exp. Biol. and Med.*, 22:353-357.
5. CAMERON, A. L. 1923. A study of the developmental topography of the organs of the abdomen, with particular reference to their congenital abnormalities and displacements. (Ms. of unpublished thesis for the degree of Ph. D., Univ. Minn.)
6. CAMPER, P. 1821. The works of the late Professor Camper, on the connection between the science of anatomy and the arts of drawing, painting, statuary, etc. A new edition (and translation) by T. Cogan, *London.*
7. CLOQUET, J. 1826. Anatomie de l'homme ou description et figures lithographiées de toutes les parties du corps humaine. 5 vols. *Bruxelles.*
8. CRUMMER, L. R. 1927. Visceral manikins in carved ivory. *Amer. Jour. Obstet. and Gynecol.*, 13:26-29.
9. DONALDSON, H. H. 1895. The growth of the brain. 374 pp. *London.*
10. DUNN, H. L. 1921. The growth of the central nervous system in the human fetus as expressed by graphic analysis and empirical formulae. *Jour. Comp. Neurol.*, 33:405-491.
11. FRANK, M. 1920. History and bibliography of anatomic illustration, by Ludwig Choulant. Translated and edited by Mortimer Frank. xxvii + 435 pp. + 25 pl. *Chicago*: The Univ. Chicago Press.
12. FUNKHOUSER, H. G. 1936. A note on a tenth century graph. *Osiris*, 1:260-262.
13. ————. 1937. Historical development of the graphical representation of statistical data. *Osiris*, 3:269-404.
14. GEYER, O. 1902. Der Mensch: Hand- und Lehrbuch der Masse, Knocken und Muskeln des menschlichen Körpers, 2nd ed. viii + 139 pp. + 14 pl. *Berlin.*

15. HESDORFFER, M. B. and SCAMMON, R. E. 1935. Growth of human nervous system. I. Growth of cerebral surface. *Proc. Soc. Exp. Biol. and Med.*, 33:415-418.

16. ———— and SCAMMON, R. E. 1936. Studies on the growth of the human nervous system. IV. Material illustrating the postnatal growth and topography of the basal nuclei. *Anat. Rec.*, 64: 443-452.

17. HILDEBRANDT, F. 1830. Handbuch des Anatomie des Menschen. Vierte umgearbeite und sehr vermehrte Ausgabe besorgt von E. H. Weber, 4 vols. *Braunschweig.*

18. HIS, W. 1880-1885. Anatomie menschlicher Embryonen, 3 vols. + atlas. *Leipzig.*

19. HOLL, M. 1898. Uber Gesichtsbildung. *Mitteil. a. d. anthrop. Gesellsch. z. Wien*, 28: 57-100.

20. HORSLEY, V. 1892. A chapter on cranio-cerebral topography. *Cunningham Memoirs, Roy. Irish Acad., Dublin*, No. VII.

21. HUETER, C. 1865. Die Formentwickelung am Skelet des menschlichen Thorax. 100 pp. *Wien.*

22. HYRTL, J. 1889. Lehrbuch der Anatomie des Menschen. 20th ed. xviii + 1018 pp., *Wien.*

23. JACKSON, C. M. 1909. On the developmental topography of the thoracic and abdominal viscera. *Anat. Rec.* 3: 361-396.

24. KING, W. I. 1916. Elements of statistical method. 250 pp. *London*: The Macmillan Co.

25. LANGER, C. 1884. Anatomie der äusseren Formen des menschlichen Körpers. xii + 296 pp., *Wien.*

26. MALL, F. P. 1893. Early human embryos and the mode of their preservation. *Bull. Johns Hopkins Hosp.*, 4:115-121.

27. MCKINLEY, J. C. 1917. The musculature of the newborn (Ms. of unpublished thesis for the degree of M. A., Univ. Minn.)

28. MEAD, C. H. 1930. A quantitative study in human teratology. HUMAN BIOL., 2:1-33.

29. MERKEL, F. 1882. Beitrag zur Kenntniss der postembryonalen Entwicklung des menschlichen Schädels. *In:* Beitr. zur Anatomie und Embryologie als Festgabe Jacob Henle zum 4. April 1882 dargebracht von seinen Schülern, pp. 164-183 + pl. 14-20. *Bonn.*

30. ————. 1885-1907. Handbuch des topographischen Anatomie, 3 vols. *Braunschweig.*

31. ————. 1903. Bemerkungen zum Beckenwachtstum. *Anat. Hefte*, 20:123-150.

32. NANÃGAS, J. C. 1925. A comparison of the growth of the body dimensions of anencephelic human fetuses with normal fetal growth as determined by graphic analysis and empirical formulae. *Amer. Jour. Anat.*, 35:455-494.

33. OLIVI, G. 1792. Zoologia Adriatica ossia catalogo ragionato degli animali del Golfo e delle Lagune di Venezia. *Bassano.*

34. PEARL, R. 1930. Introduction to medical biometry and statistics. 2nd ed., rev. and enl. 459 pp. *Phila.* and *London:* W. B. Saunders Co.

36. PEYTON, W. T. 1933. A study of developmental cranio-cerebral topography

as determined by the orthoscopic method. *Jour. Nerv. and Mental. Dis.*, 78:232-249, 381-399.

37. ————. 1940. A topographic study of the orbit and bulbus oculi during a part of the growth period. *Anat. Rec.*, 76:343-355.

38. PIERSOL, G. A. 1923. Human anatomy. 8th ed. *Philadelphia:* J. B. Lippincott Co.

39. QUETELET, A. 1842. A treatise on man and the development of his faculties. Trans. by R. Knox. x + 5-126 pp. + 9 pl. *Edinburgh.*

40. ————. 1870. Anthropométrie ou mesure des différentes facultés de l'homme. 479 pp. + 2 pl. *Bruxelles, Leipzig* and *Gand.*

41. SCAMMON, R. E. 1923. A summary of the anatomy of the infant and child. *In:* Abt's *Pediatrics,* chapter III, vol. 1, pp. 257-444. *Philadelphia* and *London:* W. B. Saunders Co.

42. ————. 1927. Studies on the growth and structure of the infant thorax. *Radiology,* 9:89-103.

43. ———— and CALKINS, L. A. 1923. Simple empirical formulae for expressing the lineal growth of the human fetus. *Proc. Soc. Exp. Biol. and Med.*, 21:253-256.

44. ———— and CALKINS, L. A. 1929. The development and growth of the external dimensions of the human body in the fetal period. xxiii + 367 pp. *Minneapolis:* Univ. Minn. Press.

45. ———— and HESDORFFER, M. B. 1935. Growth of human nervous system. II. Indices of relation of cerebral volume to surface in developmental period. *Proc. Soc. Exp. Biol. and Med.* 33:418-421.

46. ———— and HESDORFFER, M. B. 1936. Growth of human nervous system. III. Relations between cerebral surface, volume and length. *Proc. Soc. Exp. Biol. and Med.*, 34:273-277.

47. ———— and HESDORFFER, M. B. 1937. Growth in mass and volume of the human lens in postnatal life. *Arch. Ophth.*, 17: 104-112.

48. SOEMMERING, S. T. 1796-1800. Vom Baue des menschlichen Korpers. 2nd rev. ed. 5 vols. *Frankfurt am Main.*

49. STRATZ, C. H. 1909. Der Korper des Kindes und seine Pflege. 3rd ed. xviii + 386 pp. + 4 pl. *Stuttgart:* F. Enke.

50. ————. 1926. Lebensalter und Geschlechter. xii + 194 pp. + 1 pl. *Stuttgart:* F. Enke.

51. THOMPSON, C. S. J. 1925. Anatomic manikins. *Jour. Anat.*, 59:4.

52. THOMPSON, D'A. W. 1915. Morphology and mathematics. *Trans. Roy. Soc. Edinburgh,* 50:857-895.

53. ————. 1917. On growth and form. xvi + 793 pp. *Cambridge:* At the University Press.

54. VOGT, E. C. and VICKERS, V. S. 1938. Osseous growth and development. *Radiology,* 31:441-444.

55. WILMER, H. A. 1940. Quantitative growth of the skin and subcutaneous tissue in relation to human surface area. *Proc. Soc. Exp. Biol. and Med.*, 43:386-388.

56. ————. 1940. Changes in structural components of human body from six lunar months to maturity. *Proc. Soc. Exp. Biol. and Med.*, 43:545-547.

THE RELATION OF COUNTRY OF ORIGIN TO MORTALITY FOR VARIOUS CAUSES IN NEW YORK STATE[1]

BY MASSIMO CALABRESI

Department of Public Health, Yale School of Medicine

OBJECT OF STUDY

THE early decades of the twentieth century, in the United States, presented an unusual opportunity to study variations in susceptibility to disease among various national and "racial" groups on account of the fact that so considerable a section of its population was of foreign birth. The classic study on this point was made by Dublin and Baker (1920) (1). This investigation was based on the mortality of certain important groups of foreign-born white residents in New York and Pennsylvania in 1910. The general conclusions reached in these investigations may be summarized as follows:

(1) The death rates of the foreign-born population, for all causes and for some specific causes, are higher than the corresponding death rates of the native-born of native parentage.

(2) The death rates of different national groups vary considerably. While the Italians, the Austrians, and the Russians (largely Russian Jews) present relatively low death rates, the mortality figures for the British, the Germans, and especially for the Irish, are far in excess of those for other groups.

(3) Pulmonary tuberculosis, pneumonia, the degenerative diseases, and cancer are largely responsible for these results.

(4) The death rates of the Germans, the British, and again especially of the Irish, in the United States, are much higher than the corresponding rates in the respective countries of origin.

While these results have been generally accepted and are still frequently quoted, the need of further and more extensive information was expressed by Dublin himself and also by Carpenter (1917) (2). In the

[1] Based on a dissertation presented to the Faculty of the Yale School of Medicine in partial completion of the requirements for the degree of Doctor of Public Health.

statistics presented by Dublin, the age-specific death rates for ages over 24 are given by twenty-year periods. Yet if one examines the age distribution of the different national groups, it may be shown that large differences in mortality rates within these broad age periods should be expected as a result of the higher average age of some foreign-born groups as compared with others. Due solely to such differences in age distribution, the rates should be higher among the "old" immigrants, that is, among those groups of the foreign-born who show the most unfavorable rates in Dublin's statistics. This point has been raised by Arner (1933) (3).

In view of the practical and theoretical importance of the subject, it seemed desirable to analyze more recent data, again from the standpoint of country of origin, but with the computation of specific death rates by smaller age intervals.

SOURCES OF DATA

The returns of the Census of 1930 give special tabulations of the foreign-born white population from selected countries of birth by sex and age in five-year periods, for twelve selected states and five cities. Data regarding the mortality of the foreign-born, by country of origin and by age, are not available in the vital statistical reports of the same states and cities. The basic information analyzed in the present paper has been obtained through the courtesy of the Director of the Division of Vital Statistics of New York State, Dr. J. V. De Porte, and of the Commissioner of Health of New York City, Dr. E. Stebbins, to whom I wish to express my thanks.

The data obtained for New York State, exclusive of New York City, include the number of deaths from all causes and from some specific causes for each of the five years, 1928 to 1932, by sex and broad age periods, of the foreign-born white population from certain selected countries. The data from New York City include only the mortality from all causes for each of the five years, 1928 to 1932, for similar groups of foreign-born residents.

The specific causes of death analyzed in the following pages, with the corresponding numbers of the International List of Causes of Death (4th edition, 1929), are: diseases of the heart (Nos. 90-95); nephritis (Nos. 130-132); diabetes (No. 59); cancer and other malig-

nant tumors (Nos. 45-54); tuberculosis (Nos. 23-32); and pneumonia (Nos. 107-109).

The nationalities of the populations included in the present study are: Italian; English, Scotch, and Welsh pooled together; German; Canadian; Polish; and Irish. The Russians have been studied with regard to all causes only, both in New York State and in New York City.

METHOD OF ANALYSIS

In order to remove the effect of differences in the age distribution of the population groups studied, it was necessary to adjust mortality rates for age, and to employ for this purpose reasonably narrow age periods. As the number of deaths in the basic statistics was given only by broad age periods for New York State, and without subdivision in age groups for New York City, the death rates had to be adjusted by an indirect method[2].

The actual records of deaths available for New York State were tabulated in only five classes: under 20 years, 20-24 years, 25-44 years, 45-64 years, and over 65 years. These classes were too large to be useful. Therefore, the average crude death rate for all ages for the five years 1928 to 1932 was first computed for each of the selected causes of death.

The actual age distribution of the population of each group (by country of origin) was taken from the Report of the Fifteenth Census on *Age of the Foreign-born White Population by Country of Birth* (Arner, 1933), which gives the age data by five-year periods (after age 20, and under 75) for New York State in 1930. From these data, the crude death rates for each group were converted to the adjusted death rates which would have obtained if the age distribution of each had been that of the white population of the Registration Area in 1930.

The age-adjusted death rates from all causes for each group of foreign-born residents of New York City (both sexes) were computed with the same procedure, using the same standard population, the average crude death rates for the five years 1928 to 1932, and the actual age distribution of the foreign-born population, by country of origin, in 1930, as given in the Census Report quoted above.

---

[2] The method used is that employed by the Registrar-General of England and Wales.

The importance of using narrow age-periods in such a study as this is illustrated in Tables 1 and 2, in which—for the same data used by Dublin—the crude death rates have been compared with the age-adjusted death rates. It will be noted that the crude death rates place the

TABLE 1

Crude and age-adjusted death rates per 1000 among persons born in Germany, Ireland, and Italy, for all causes, by sex: New York State, 1910

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
Germany	225,161	27.5	16.2	211,713	22.6	12.6
Ireland	155,276	40.2	22.9	212,601	34.8	20.8
Italy	285,435	9.2	14.4	186,757	9.0	13.4

German group in a highly unfavorable position as compared with the Italian group, a difference which is obliterated or reversed when the age-adjusted death rates are considered. Furthermore, both the Irish and

TABLE 2

Crude and age-adjusted death rates per 1000 among persons born in Germany, Ireland, and Italy, for all causes, by sex: Pennsylvania, 1910

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
Germany	101,195	28.2	15.0	93,990	23.5	12.4
Ireland	72,647	40.6	20.5	92,444	35.0	18.7
Italy	137,390	9.8	17.5	58,732	9.0	14.4

the German groups show up much better in age-adjusted than in crude death rates. Clearly, the extreme differences recorded by the crude

death rates were enormously influenced by the fact that—within a wide age-group—the Irish and the Germans had a much higher mean age than did the Italians.

That the five-year age-periods are sufficiently narrow for our purpose was established by applying the constant age specific mortality rates to the five-year and also to the one-year age distributions for the total population of each national group in the twelve states as given in the Census Report, and obtaining essentially the same results.

In the original tabulations, some of the population groups included in this study were divided by mother-tongue or other ethnic classifications: the English were distinguished from the Scotch and the Welsh, and the Northern Irish from the people born in Eire; the Canadians were divided into French and all others; the population born in Poland was divided by mother-tongue into Polish, Yiddish, and others. As the data for mortality were not so subdivided, these subgroups were pooled together in our analysis.

GENERAL RESULTS

The age-adjusted death rates for all causes and for each of the specific causes analyzed, together with the crude death rates, are given in Tables 3 to 10.

It will be of interest, first of all, to compare the mortality rates of the native-born white population with those of the total foreign-born. In previous works on this subject the native-born have been frequently divided into two classes, those born of native parentage and those born of foreign parentage. This subdivision has not been followed here, for two reasons. Many of the native-born of native parentage in 1930 represent the third generation of immigrants coming to the United States during the last century, and are not descendants of earlier American stock. The percentage of native-born of mixed parentage or of parentage not stated or incompletely stated is very high, and it is felt that any attempt to redistribute them is somewhat arbitrary and open to criticism.

The figures for the total foreign-born white are presented, primarily because they give probably the best basis for comparison of the rates observed and calculated for each national group.

While, as was expected, the crude mortality rates for the foreign-born are far in excess of the corresponding rates for the native-born,

after having removed the age factor we find that the foreign-born population still compares unfavorably with the native-born. This general conclusion is valid for the mortality from all causes and also for the adjusted rates for each specific cause, with only two exceptions: the mortality rates of the foreign-born males for nephritis and for diabetes. The interpretation of these two exceptions will become evident later, when the specific rates of the different national groups are considered. It is remarkable, on the other hand, that one of the extreme cases of excess mortality among the foreign-born is the diabetes rate for females. Also, the mortality rate among foreign-born males for pneumonia is far in excess of the corresponding rate of the native-born; no doubt this results in part from occupational hazards and from economic factors.

On the whole, however, the differences for both sexes are smaller than one might have expected, considering the obviously lower standard of living of the foreign-born. We shall see that some of the "old" immigrants have mortality rates in excess of the rest of the population; and similar results have been reported also for their children. It is possible that the influence of native-born descendants of these particular stocks is a factor tending to equalize the mortality of the native and the foreign-born population.

Mortality from all causes

Data for each country of origin, with respect to the death rate from all causes, are presented in Table 3 (New York State, exclusive of New York City), and Table 4 (New York City).

It is apparent that, for each sex in the State and for the sexes combined in New York City, the Italians have the lowest death rate from all causes (10.4—11.1 per 1,000 population) of any foreign-born group, except for the abnormal rate for the Poles in New York City. For males, their rate is below the native-born; for females slightly above.

The English-Scotch-Welsh group, the native-born group, and the German group come next (rates of 10.2—12.6). The Canadian group shows slightly higher rates in the State (11.7—12.9) and a much higher rate in New York City (14.0).

The Polish group shows startling anomalies, with a rate of 13.8 for State males, 10.5 for State females and 6.8 for New York City. The high proportion of Jews in New York City might contribute in some

TABLE 3

Crude and age-adjusted death rates per 1,000 population, for all causes, by country of birth and sex: New York State, exclusive of New York City, 1928-1932

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	12.3	11.8	2,346,973	11.0	10.2
Total foreign countries	473,356	19.5	12.9	424,793	18.4	11.4
Italy	110,661	11.1	10.4	78,411	11.0	10.4
England, Scotland, and Wales	51,937	21.5	11.5	50,767	20.0	10.7
Germany	56,549	31.5	12.6	55,059	28.6	11.0
Canada	50,987	19.9	12.9	57,265	18.9	11.7
Poland	60,856	15.8	13.8	51,188	10.7	10.5
Ireland	29,533	39.5	16.5	43,061	34.6	15.0
Russia	21,770	19.8	17.4	17,087	15.2	14.0

degree to this result, since the Jews usually show low mortality rates. The expected deaths from all causes were computed for the Yiddish-speaking and for all the other Polish-born, both in New York State and in New York City. It was found that the Yiddish-speaking population contributed 8.5 per cent in New York State and 60.4 in New York City to the total calculated deaths of the Polish-born. Similar computations were also made for the Russian population; in New York City, 78.5 per cent of the expected deaths belong to the Yiddish-speaking Russian-born, while in the rest of the State this percentage is only 60.5. It is most improbable, however, that the supposedly favorable influence of the Jewish population can suffice to explain the abnormalities of our

TABLE 4

Crude and age-adjusted death rates per 1,000 population, for all causes, by by country of birth: New York City, 1928-1932

COUNTRY OF BIRTH	Population	Crude death rate	Age-adjusted death rate
Italy	440,250	12.2	11.1
England, Scotland, and Wales	118,441	15.7	12.4
Germany	237,588	21.2	12.3
Canada	39,622	14.6	14.0
Poland	238,339	6.8	6.8
Ireland	220,631	24.7	17.6
Russia	442,449	14.9	14.0

results. The apparent death rate for the Poles in New York City is certainly too low; and on the other hand the mortality of the Russians in New York State is probably too high.

The probable and adequate explanation of these aberrant results is in the changes of boundaries due to the First World War. It is probable that the Census report assigns correctly the living population to the different countries according to their legal boundaries as of 1930, while the death certificates often report the country of birth as indicated in the original documents of the deceased. Obviously this would tend to increase the death rates of the Russians and to decrease the corresponding rates of the Poles. In an attempt to confirm this interpretation the mortality rate for all causes of the small group of Austrian-born residents in New York State, exclusive of New York City, was calculated with the usual procedure: the exceedingly high adjusted rate of 24.9 per 1,000 population was found, which is in accord with our hypothesis.

If such considerations are correct, the already high mortality of the Polish-born males for cancer, tuberculosis, and pneumonia should be considered as probably lower than the real figures for this population.

Although no exact analysis is warranted on such a basis, it may be noted that, while in all other national groups the mortality is higher in New York City than in the rest of the State, the opposite is true for the Poles and Russians. This may perhaps be taken as an indication of the favorable influence of the Jewish population.

Finally, the Irish group shows uniformly high rates (15.0—17.6).

The death-rates from all causes are much less significant than the mortality rates specific for cause, which will next be considered.

Mortality from diseases of the heart

Data in regard to this important factor in the death rate are summarized in Table 5.

TABLE 5

Crude and age-adjusted death rates per 100,000 population for diseases of the heart (Int. List Nos. 90-95), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

	MALES			FEMALES		
COUNTRY OF BIRTH	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	294.9	284.7	2,346,973	255.5	228.7
Total foreign countries	473,356	536.2	291.7	424,793	544.7	276.8
Italy	110,661	236.8	206.3	78,411	294.6	262.3
England, Scotland, and Wales	51,937	650.8	273.4	50,767	543.7	227.7
Germany	56,549	997.4	296.0	55,059	917.2	258.6
Canada	50,987	617.8	330.7	57,265	579.8	291.3
Poland	60,856	364.8	289.7	51,188	283.3	264.1
Ireland	29,533	1263.0	395.1	43,061	1140.2	370.2

The general correlation between mortality from all causes and mortality from diseases of the heart is close, as might be expected. The Italian heart disease rate for males is lowest (206 per 100,000 population), but for females it is 262, higher than for the British, Germans, or native-born. In all other instances, the male rate for heart disease is higher than the rate for females. This subject will be discussed in a later paragraph. The British rate is lowest for females (228) and second lowest for males (273).

All the other four foreign-born groups show rates for all causes and for heart disease higher than those for the native-born. (No data are given for specific causes in the Russian group, since the numbers involved seemed too small to warrant such an analysis.)

TABLE 6

Crude and age-adjusted death rates per 100,000 population, for nephritis (Int. List Nos. 130-132), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	102.5	100.5	2,346,973	99.9	90.2
Total foreign countries	473,356	176.4	95.9	424,793	198.9	101.5
Italy	110,661	84.0	75.3	78,411	107.1	91.1
England, Scotland, and Wales	51,937	217.6	89.9	50,767	202.9	86.3
Germany	56,549	362.5	105.3	55,059	356.0	104.2
Canada	50,987	180.4	95.6	57,265	202.6	103.7
Poland	60,856	115.0	94.1	51,188	123.1	119.0
Ireland	29,533	409.7	125.7	43,061	387.8	129.3

The German rates (259—296) and the Polish rates (264—290) for heart disease are about 8 per cent above the rates for the native-born. On the other hand, the Canadian rates are over 20 per cent higher than those for the native-born and the Irish rates nearly 50 per cent higher.

Mortality from nephritis

The mortality rates for nephritis are presented in Table 6.

In general, the relationships are somewhat similar to those for heart disease, as would be expected since cases of hypertensive cardiovascular disease are often included under this heading. The Italians and the British show the most favorable rates, the Italians being lowest for males (75.3) and third lowest for females (91.1), the British second lowest for males (89.9) and lowest for females (86.3).

The Irish show the highest rates of all (125.7 for males, and 129.3 for females). The Germans and the Canadians show high rates (about 100 for both groups and both sexes).

The Poles exhibit a marked anomaly with a low rate for males (94.1) and the second highest rate for females (119.0). The cause of this phenomenon is obscure.

Mortality from diabetes

The data for diabetes are indicated in Table 7.

The most striking phenomenon here is the fact that the Italians and Poles show the two lowest rates for males (15.8 in both cases) and the two highest rates for females (44.2 and 43.6).

For males the German rate is highest (25.9). For females, the United States, Canadian, and British rates are low (26.5—28.7). This is the only cause of death which does not show excessive rates for the Irish.

The revelation of a diabetes rate for Italian and Polish women 175 per cent to 180 per cent in excess of that recorded for males of the same national origin is a very striking phenomenon. The corresponding excess for the Irish is 86 per cent and for other groups much less.

The fact that no such marked excess occurs in southern Italy, from which area most of the Italian immigration comes, suggests the possibility that the extreme obesity often observed among Italians in this country may be a main factor at work. If so, we have an interesting example

TABLE 7

Crude and age-adjusted death rates per 100,000 population, for diabetes, (Int. List No. 59), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	18.9	18.8	2,346,973	28.9	26.5
Total foreign countries	473,356	32.7	18.7	424,793	72.3	37.9
Italy	110,661	18.1	15.8	78,411	53.6	44.2
England, Scotland, and Wales	51,937	38.5	17.5	50,767	61.1	27.8
Germany	56,549	81.3	25.9	55,059	119.9	38.0
Canada	50,987	35.3	20.3	57,265	55.9	28.7
Poland	60,856	19.7	15.8	51,188	52.7	43.6
Ireland	29,533	57.6	19.1	43,061	102.2	35.5

of a health hazard created by exposure to an environment more favorable from a general economic standpoint than the environment to which the national group has been accustomed.

Mortality from cancer

The data for cancer mortality are presented in Table 8.

It will be noted that—as in the case of most other diseases—the Italians show the lowest rates for both sexes (80.8—94.3). The Irish show the second highest rate for males (132.1) and the highest for females. The Germans show a high rate for males (120.9); and the Canadians a high rate for females (132.8).

TABLE 8

Crude and age-adjusted death rates per 100,000 population, for cancer, all forms (Int. List Nos. 45-54), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	92.4	95.3	2,346,973	133.6	124.1
Total foreign countries	473,356	212.1	114.3	424,793	246.0	126.5
Italy	110,661	94.0	80.8	78,411	126.3	94.3
England, Scotland, and Wales	51,937	263.8	89.2	50,767	313.2	142.0
Germany	56,549	390.8	120.9	55,059	386.9	129.2
Canada	50,987	198.1	107.3	57,265	251.5	132.8
Poland	60,856	182.4	133.2	51,188	136.7	98.0
Ireland	29,533	406.3	132.1	43,061	401.7	146.4

Striking abnormalities appear with the British and the Poles. The Poles have the highest rate for males (133.2) and the second lowest rate for females (98.0). This is the only case in which a cancer rate for males is recorded in excess of that for females. The cause of this phenomenon is obscure.

The second peculiar phenomenon appears in the case of the British with the second lowest rate for males (89.2) and the second highest for females (142.0). The high cancer mortality for British females is in agreement with the well-known high prevalence of cancer of the sexual organs among the females in Great Britain as compared with other countries (4). But the low mortality for the same cause among the British-born males tends to disprove the opinion expressed by Pit-

tard, on the basis of an anthropological survey (Niceforo and Pittard, 1926) (5), that the *Homo nordicus* is more susceptible to cancer than is any other racial subdivision of the white stock. We may note incidentally that Niceforo, while agreeing with his colleague on the lower incidence of cancer among the Mediterraneans, does not find significant differences between the "Alpine" and the "Nordic" types.

In a recent investigation on the increase of cancer in Brazil during the current century the rate of increase was highest among the Anglo-Americans, while the Italians had the lowest increase of any group of the white population (6).

Mortality from tuberculosis

Data with regard to tuberculosis are indicated in Table 9.

There it will be noted that mortality rates for German and British

TABLE 9

Crude and age-adjusted death rates per 100,000 population for tuberculosis, all forms (Int. List Nos. 23-32), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

COUNTRY OF BIRTH	MALES			FEMALES		
	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	65.3	67.7	2,346,973	51.1	51.5
Total foreign countries	473,356	121.5	81.0	424,793	73.0	57.5
Italy	110,661	75.9	52.3	78,411	57.4	46.8
England, Scotland, and Wales	51,937	86.6	57.1	50,767	51.2	38.2
Germany	56,549	92.0	56.9	55,059	49.0	36.0
Canada	50,987	66.7	49.1	57,265	55.9	46.3
Poland	60,856	170.9	110.1	51,188	78.4	63.0
Irela .	29,533	165.9	103.7	43,061	113.8	84.5

females are very low (36.0 and 38.2, respectively). Rates for German and British males, native-born females, and Canadians and Italians of both sexes are moderately low (between 46 and 57). Rates for native-born males and Polish females were somewhat higher (67.7 and 63.0, respectively). Rates for Irish females (84.5), Irish males (103.7) and Polish males (110.1) were extremely high. The very marked excess of the male rate among the Poles is notable.

Mortality from pneumonia

In Table 10 are presented the data for pneumonia.

Here there appear certain marked departures from the distribution of mortality from other causes. The British, German, and native-born

TABLE 10

Crude and age-adjusted death rates per 100,000 population, for pneumonia, all forms (Int. List Nos. 107-109), by country of birth and sex: New York State, exclusive of New York City, 1928-1932

	MALES			FEMALES		
COUNTRY OF BIRTH	Population	Crude death rate	Age-adjusted death rate	Population	Crude death rate	Age-adjusted death rate
United States	2,317,946	88.7	87.9	2,346,973	73.3	68.4
Total foreign countries	473,356	135.2	106.6	424,793	106.2	79.4
Italy	110,661	108.4	113.6	78,411	76.5	86.9
England, Scotland, and Wales	51,937	127.1	83.6	50,767	108.3	69.4
Germany	56,549	161.0	83.4	55,059	143.5	65.6
Canada	50,987	119.6	92.2	57,265	101.3	73.1
Poland	60,856	133.1	129.2	51,188	48.8	58.7
Ireland	29,533	284.4	154.0	43,061	225.3	115.9

rates remain low (between 83 and 88 for males, between 66 and 69 for females). The Italians on the other hand show high rates (113.6 for males and 86.9 for females). The Poles exhibit (as in the case of tuberculosis) an enormous sex differential; the female rate is very low indeed, the lowest for any group (58.7), but the male rate is the second highest registered (129.2), more than double the female rate. Is it possible that the error as to country of origin, mentioned above, may influence females more than males?

The Irish, as usual, are in a highly unfavorable position, with rates of 115.9 for females and 154.0 for males.

REVIEW OF CHARACTERISTICS OF VARIOUS NATIONAL GROUPS

Perhaps the clearest idea of the relative mortality rates of the groups considered may be gained from Table 11, in which there is indicated for each cause of death the ordinal rating of country of origin in the series of seven groups represented.

The native-born occupy in general a median position in the series, as might be expected from the fact that this group represents a wide mixture of racial stocks. Among the rates for males, those of the native-born appear under each cause of death in third, fourth or fifth place. Among females, however, the position of the native-born group is much more favorable. It ranks first in deaths from all causes and from diabetes, second in respect to heart disease and nephritis. It seems possible that this favorable status of native-born females may be due to higher economic status.

Rates for the Italians

The best showing in the entire series of groups is made by the Italians. Their males rank in first or second place except for pneumonia where they fall to fifth place. The picture for females is less favorable. They stand fourth with regard to heart disease and tuberculosis, sixth with regard to pneumonia and seventh with regard to diabetes. In general, we are dealing here with a group of relatively low economic status, and there may be in this case a phenomenon the obverse of that shown in the case of the native-born.

The low mortality from heart disease and from nephritis among the Italian males, and from cancer for both sexes is especially significant. Moreover, the mortality from tuberculosis is favorable, and lower than

TABLE 11

Ordinal ranking of age-adjusted death rates from specified causes among seven national groups studied, by sex

CAUSE OF DEATH	COUNTRY OF ORIGIN													
	Italy		England, Scotland, and Wales		United States		Germany		Canada		Poland		Ireland	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
All causes	1	2	2	4	3	1	4	5	5	6	6	3	7	7
Heart disease	1	4	2	1	3	2	5	3	6	6	4	5	7	7
Nephritis	1	3	2	1	5	2	6	5	4	4	3	6	7	7
Diabetes	1*	7	3	2	4	1	7	5	6	3	1*	6	5	4
Cancer	1	1	2	6	3	3	5	4	4	5	7	2	6	7
Tuberculosis	2	4	4	2	5	5	3	1	1	3	7	6	6	7
Pneumonia	5	6	2	4	3	3	1	2	4	5	6	1	7	7

* Italy and Poland tied for first place.

among the native-born. On the other hand, the high mortality from pneumonia for both sexes and from diabetes for the females is striking.

These results are in general agreement with other information obtained from the literature. In the statistics of Dublin for 1910, the Italians were in a favorable position, and the age adjustment by five-year periods (Tables 1 and 2) does not change the validity of his conclusions. The low rate for cancer among the natives born of Italian parentage, as observed in the statistics of Carpenter (1917), is remarkable. Parkhurst (1933) (7) gives the extremely low rate of 36.6 per 100,000 for tuberculosis among the second generation of Italian origin, in New York State, exclusive of New York City (average for the years 1929-1931); this rate is not adjusted for age, but it is probably safe to compare it with the rate of 59.3 for the children of parents born in Eastern and Central Europe.

On the other hand, the high rate for pneumonia is in agreement with the figures of Dublin and also with the results of Carpenter for the second generation. The mortality from influenza during the great epidemic of 1918-1919 was very high among the Italian colonies in the United States, and also among the Italians in their native country (8) (9). The death rate for pneumonia in Italy is one of the highest among the European populations. It is probable that the exposure of the Italian laborers may explain their unfavorable position in regard to the acute respiratory diseases. However, the high prevalence among the Italian females and in the second generation may possibly indicate a greater susceptibility.

The very high mortality from diabetes of the Italian females, as noted above, does not correspond with the parallel figures in southern Italy. It has been suggested that the extreme obesity frequently observed among the Italian females in this country may contribute to this result.

The contrast between the Italians and the Irish, both rural populations in their country of origin and highly urbanized in the United States, both largely formed by initially unskilled general laborers, both of the Catholic religion, could not be more striking. Certainly the difference cannot be ascribed to economic factors, especially in 1910 when the Italian immigrants were newcomers and at the lowest economic level.

While probably other factors contribute to the favorable position of the Italians, it may be pointed out that they belong to one of the

* Italy and Poland tied for first place.

oldest European civilizations, and also that, in spite of their prevalent occupation, the southern Italians do not live in isolation but rather are concentrated in the so-called rural towns, where they have most of the disadvantages of the rural and also of the urban environment. The selective effect of this condition may have operated among the ancestors of these peasants as among other predominantly urban populations.

Rates for the British

The experience of the British stock (England, Wales, and Scotland) is, again, also extremely favorable.

Males rank in second place, except for diabetes (third place) and tuberculosis (fourth place). Females rank in first or second place, except for pneumonia (fourth place) and cancer (sixth place).

In the Dublin study the British occupied a rather unfavorable position. Unfortunately we do not have for this nationality the tabulation for age by five-year periods as for the Germans, Irish, and Italians; it is however fair to assume that if the effect of age differences could have been removed, the mortality of the British in 1910 would have been lower, and not too different from the death rates of the natives.

The low mortality of both sexes from nephritis and from pneumonia, and of the females from tuberculosis may be emphasized. The high rate for cancer of the sexual organs among females, as has already been noted, is a phenomenon which has already been recorded by Greenwood (4).

We now pass to the groups by country of origin which show less favorable results than the native-born.

Rates for the Germans

The population of German origin does not show anything like the unfavorable results found by Dublin. Since the Germans have the highest median age among our national groups, the effect of removing the age factor would be expected to be most marked. The German group does, however, show rates somewhat higher than those for the native-born.

Males of German origin rank in third to fifth place, except for pneumonia (first place), nephritis (sixth place), and diabetes (seventh place). Females rank in third to fifth place, except for pneumonia (second place), and tuberculosis (first place). In contrast with the

figures given by Dublin, the rate for tuberculosis among the German males is distinctly below those of the total foreign-born and also that of the native-born, while the very favorable position of the German females is confirmed by our material. Another definite difference is given by the mortality from pneumonia, the German males having the lowest death rate for this disease, and the females the second lowest. The death rate for diabetes, especially among the males, is remarkably high.

Rates for the Canadians

The mortality experience of the Canadians is definitely less favorable than that of the Germans. The males of this group rank in the fourth to the sixth class, except for tuberculosis where they have the lowest rate recorded. The females also rank in the fourth to the sixth group, except for diabetes and tuberculosis (both third group).

The total result is determined especially by the unfavorable position of the Canadians with regard to heart disease; moreover the mortality from cancer is rather high among the females, although lower than among the Irish and the British. The high mortality from heart disease is in agreement with the figures given by Carpenter, for the native-born residents of Canadian stock in the state of New York in 1920. On the other hand, the females have a favorable position for diabetes, and the men for tuberculosis, their mortality for this cause being lower than the corresponding rates for any other group.

Although extra-European by birth, from an anthropological point of view the Canadian-born population does not differ from other immigrants arrived directly from Europe. In our statistics the French Canadians are given separately from the others; they amount to less than one-fourth of the total of the residents in New York born in the Dominion. For all practical purposes all other Canadian-born may be considered as originating from Great Britain or Ireland.

The rather unfavorable position of this national group deserves special attention in view of the active movement of population in both directions through the northern boundaries of the United States during the last decades.

Although in the last fifty years Canada has received a substantial number of immigrants from other European countries, the remote origin of the population coming to the United States is essentially French, British or Irish. The marked difference between the Canadians

and the Irish-born with regard to tuberculosis must therefore be underlined.

More extensive and also more detailed information would be needed in order to determine the contribution of the original ethnic stocks entering into the present Canadian population to the relatively high mortality observed.

Rates for the Poles

The males of the Polish group are in sixth or seventh place except for heart disease (fourth place), nephritis (third place), and diabetes (tied with the Italians for the first place). The females are in sixth place, except for heart disease (fifth place), cancer (second place), and pneumonia (first place).

While the immigration from Poland includes a large percentage of Jews, the Jewish population of Polish birth in New York State, exclusive of New York City, is relatively much less, due to the high concentration of the Jews in the city. The subdivision by mother-tongue gives 7 per cent Yiddish-speaking persons among the Polish-born residents of the State, exclusive of New York City. Although this classification certainly tends to understate the percentage of the Jews, they probably account for less than 10 per cent of the total Polish immigrants in that area.

In other respects, as duration of residence in the United States, economic level, religion, and age distribution, the Polish may be compared with the Italians.

The position of the Polish group in our statistics is rather inconsistent. They have the highest mortality among the males from cancer and tuberculosis, and the second highest from pneumonia, while the females have high rates for nephritis and diabetes and very low rates for pneumonia and cancer. The females hold the third best position in the mortality from all causes, while the corresponding rate for the males is higher than for any group except the Irish; in striking contrast with this figure, the mortality for all causes in New York City, for both sexes, is by far the lowest of all.

Rates for the Irish

As in the Dublin study, the group of Irish origin shows by far the most unfavorable results. The males of this group rank seventh

with respect to heart disease, nephritis, and pneumonia; sixth with regard to cancer and tuberculosis; and fifth with regard to diabetes. The females rank seventh with respect to every cause except diabetes, where they stand fourth.

Considering the original population of the island, the Irish immigration into the United States has been unparalleled by that of any other nationality. More than 4,500,000 persons came to this country from Ireland, while the maximum of the population in the island was estimated at 8,300,000 in 1845. The peak of the Irish immigration was reached between 1840 and 1850 although the movement continued in the following years. The importance of the Irish stock in the United States is proved by a computation made for the purpose of determining immigration quotas; the population of Irish origin (Irish Free State) in 1920 was estimated as 11.2 per cent of the total white population, the third greatest after the British and the Germans.

It has been noted that the Irish immigrants, although belonging to the "old" immigration, approach in other respects the "new" immigrants, and settled especially in urban communities of New England and of the Middle Atlantic States.

In our statistics the mortality rates for all causes for the Irish-born are far in excess of the corresponding rates for the native-born and also of the total foreign-born population. The death rate from all causes is 40 per cent higher for Irish males than for the native-born males; and for females 47 per cent higher than for native-born females. The only population showing a worse position is that of the Russian males in New York State, exclusive of New York City; but, as pointed out above, the information regarding this group of foreign-born is probably unreliable.

Except for some minor differences in details, my results for this ethnic group essentially agree with the conclusions of Dublin. In a study by Carpenter of the mortality of the native-born of foreign parentage, the second generation of Irish stock also ranked highest for such diseases as tuberculosis, cancer, heart disease, cerebrovascular accidents, and nephritis. And the resident death rate for tuberculosis for the native-born of Irish stock in New York State exclusive of New York City, in the years 1929-1931, was 114 per 100,000, while the death rate for the total group of native-born of foreign or mixed parentage was 63.3. Even considering the data of 1910, the unfavorable position of the Irish stock cannot be explained, as in the case of the

Germans, as an effect of the age distribution. As shown in Tables 1 and 2, the rates adjusted for age by five-year periods, for all causes and each sex, in Pennsylvania and New York in 1910, are still very high.

We do not have the age distribution by single years of the foreign-born residents for New York State, but the data for the twelve states of the special tabulation referred to above do not indicate a higher concentration in the older years of each five-year period for the Irish than for the Germans.

DISCUSSION

The data analyzed in the previous pages show significantly large differences in mortality among the different ethnic groups of immigrants studied. How these differences have come about, and their practical implications may be briefly considered.

In an attempt to analyze the causes of the differences observed, three questions may be proposed:

(1) Whether the hereditary constitution of different stocks may be an important determinant of differences in mortality.

In a strictly genetic sense, we cannot divide the species *Homo sapiens* into different subspecies or "races," having definite hereditary characteristics proper to each and lacking in others. But there is no reason to doubt that there is a statistical difference in the frequency distribution of genes among different groups of the human species. This has been proved for the genes responsible for the blood agglutinogens and must be true for the multiple factors expressed in the normal traits which distinguish the various so-called races of physical anthropology.

We may admit that this is true also for the specific factors of hereditary diseases and for the genes influencing the resistance to other diseases due to external causative agents. However our knowledge of human genetics is still too incomplete to warrant more specific deductions.

Without, however, attempting to base an interpretation of our results on differences in hereditary constitution, we may use the different susceptibility of various ethnic groups as a source of information in regard to the importance of heredity in the causation of disease. In this sense a study of the native-born of specified foreign parentage or descent should be of great interest. Obviously, even if we were able to prove the

higher prevalence of genetic factors of certain diseases among some ethnic groups, such statistical results could not be directly applied to single individuals.

(2) Whether environmental factors, specifically related to various groups, have produced the observed differences.

It is self-evident, and it has been proved by extensive investigations, that geographic characteristics are not the only, probably not even the most important, environmental factors in the causation of disease. Our information is too scarce and incomplete to attempt an analysis of such socioeconomic factors as rural or urban residence, occupation, income, or composition of families in relation to country of origin. The favorable position of the Italians as compared with other "new" or even "old" immigrants, not only in 1930 but also in 1910, may be taken as an indication that at least the economic situation has not had a decisive influence in determining the differences observed.

It should be noted however that more subtle differences among the various national groups, having their origin in old traditions and habits, may have greater influence on the personal hygiene and on the true standard of living than other more obvious sociological classifications, and may prove an important factor in a correct understanding of our results.

(3) Whether residence in the United States has had an influence on the mortality of different national groups.

Reference has been made to the opinion that a change from rural life to urban settlements may explain the poor position of some groups of immigrants, especially the Irish. While the slow selective effect of the centuries-old urban life of some populations, like the Jews, cannot be denied, it should be considered that the urban concentration of large sections of the population is in most countries a rather recent development. It seems unlikely that such a process has caused marked changes in the susceptibility toward disease in only a few generations.

On the other hand, the indirect effect of social changes, a life of greater opportunity and high nervous tension, conducive of continuous strenuous work, of larger earning and spending, may be differently influential on different groups, according more to their psychical than to their physical characteristics.

However it may be, an analysis of the effects, favorable or otherwise, of residence in the United States on the mortality of different ethnic stocks cannot be made by simply comparing the statistics for

each national group, available in this country and in the countries of origin. Even disregarding the differences in medical standards, we know that the statistics of mortality for specific causes in different countries are not accurately comparable owing to the lack of uniformity in the rules used in the selection of the causes of death (10). Even limiting the study to the mortality from all causes, still we may doubt whether the immigrants are representative of the whole population of the country of origin; on the contrary, at least for some countries, we know definitely that this is not the case. Finally, the duration of residence in the United States should be considered in order to weight the effect of the new environment, and also as a factor in the adjustment of the newcomers.

A study along these lines may yield interesting results, but it is obvious that it may be attempted only by one who has direct access to the original records in each country.

These brief considerations may have some bearing on the practical implications of the differences we have found.

It is self-evident that the general death rates in New York for the years 1928 to 1932 are affected by the high mortality of some of the ethnic groups considered above. While it would not be safe to generalize our results to the country as a whole, it may be remarked that the quantitative influence of these groups of foreign-born on the total mortality may be more significant than would appear from the usual statistics, in which the foreign-born of different nationalities are pooled together and compared with the native-born.

Reference has been made to some data which tend to prove that even the native-born, of different ethnic stocks, show susceptibility to disease similar to that of their parents. The results of a study by Winslow and Wang (1931) (11) may be quoted here. From an analysis of mortality of the native-born of native and of foreign parentage and of the foreign-born in the six states of Connecticut, Massachusetts, New Hampshire, New Jersey, New York, and Rhode Island, by age groups, for the period 1890-1920, it was found that the native-born of foreign parentage differed from the rest of the population in showing an increase in mortality between 1905 and 1915. In accord with the results of Dublin, it was concluded that the influence of the Irish and German stocks might have accounted for the increase in mortality. While our results tend to disprove the high mortality of the German stock, this conclusion may still be accepted as valid with regard to the Irish, and

is confirmed by the observations of Carpenter and of Parkhurst of the high mortality of the native-born of Irish descent.

As already mentioned, further studies along these lines may prove of great interest for a better understanding of the influence of heredity on disease. They should also show whether the influence of the foreign-born on the mortality in the United States is transitory or has definitively modified the demographic characteristics of the population.

Should it be proved that the lower vitality of some groups of immigrants as compared with others is inherited by their descendants, these results might well be considered with regard to the immigration policy of the United States. However, the medical aspects of immigration regulations are too complex and delicate to be discussed here. And it must be emphasized that, while good physique is an essential requirement, other moral and intellectual characters are at least as important as the physical qualities of the immigrants concerned.

SUMMARY

(1) In studying the mortality of the foreign-born population of the United States, serious errors may be introduced if wide age-intervals are employed on account of marked differences in the median age of immigrants from different countries of origin.

(2) In the present study, therefore, the mortality rates for all causes and for some selected causes of certain groups of foreign-born, divided by country of origin, in New York State, in the years 1928-1932, have been standardized for age by five-year periods. The age-corrected death rates for all causes of the foreign-born populations from Germany, Ireland and Italy, in New York and Pennsylvania, in 1910 have been computed in the same manner.

(3) When analyzed in this way, the foreign-born populations from Germany and from Great Britain fail to show the unfavorable rates of mortality reported by other observers on the basis of wider age-periods with incomplete removal of the age-factors involved. On the contrary—when analyzed by five-year age periods—the British show rates approximately comparable to or materially lower than those for the native-born and the Germans exhibit rates only slightly higher than those for the native-born.

(4) On the other hand, the remarkably low rates for immigrants from Italy are strikingly confirmed. For males, this group shows the

lowest of all rates recorded for all causes and for females the lowest rate except that for the native-born.

(5) The extremely unfavorable position of the Irish, as reported in earlier studies is also confirmed, rates for all of the causes studied, except diabetes, being inordinately high. The death rate of the Irish from all causes is more than 40 per cent higher than that for the native-born.

(6) Rates for persons of Canadian and Polish origin are generally high, falling in most cases between the rates for the Germans and those for the Irish. The rates recorded for the Poles are probably too low (notably so in New York City) on account of confusion as to actual country of origin.

(7) In certain instances, a given group shows an especially high or low susceptibility to a given disease. The outstanding examples are:

(a) High rates for pneumonia among the Italians.

(b) Low rates for tuberculosis and pneumonia among the Germans.

(c) Low rates for tuberculosis among the Canadians.

(8) Aside from such differences which more or less are found in both sexes, certain interesting differences in sex incidence come out in this study:

(a) Among the Italians, heart disease and diabetes are notably higher among females than among males.

(b) Among the British, females show an unusually high incidence of cancer.

(c) Among the native-born, nephritis and diabetes are relatively lower among females than males.

I wish to thank Miss Clara E. Councell, and especially Dr. C.-E. A. Winslow for his authoritative suggestions and constructive criticism.

REFERENCES

(1) Dublin, L. and Baker, C. W. The mortality of race stocks in Pennsylvania and New York. *J. Am. Stat. A.*: 17, 13, 1920.

(2) Carpenter, N. Immigrants and Their Children. Census Monograph VII. *U. S. Department of Commerce. Bureau of the Census*, 1917.

(3) Arner, G. B. L. Age of the Foreign-born White Population by Country of Birth. Fifteenth Census of the United States: 1930. *U. S. Department of Commerce, Bureau of the Census*, 1933.

(4) Greenwood, M. The cancer mortality rates in different countries. Report of the International Conference on Cancer, *London*, 1928, p. 490.

(5) NICEFORO, A. and PITTARD, E. Considerations sur les rapports presumés entre le cancer et la race. *Génève:* Societé des Nations, Org. d'hygiène, 1926.

(6) DE ALENCAR, J. E. *Quoted from:* Cancer and race in Brazil. An editorial. *J. A. M. A.:* 123, 650, 1943.

(7) PARKHURST, E. Resident mortality from tuberculosis in urban and rural New York. *Am. J. Pub. Health:* 23, 901, 1933.

(8) MORTARA, G. La salute pubblica in Italia durante e dopo la guerra. *New Haven:* Yale University Press, 1925.

(9) JORDAN, E. C. Epidemic Influenza. *Chicago:* Am. Med. Assoc., 1927.

(10) U. S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS. Classification of joint causes of death. *Vital Statistics, Special Reports,* 5: 385, 1938.

(11) WINSLOW, C.-E. A. and WANG. P. L. The relation between changes in nationality stock and increasing death rates in adult life. *Am. J. Hyg.:* 14, 79, 1931.

HIATUS CANALIS SACRALIS IN AMERICAN WHITES AND NEGROES[1]

BY MILDRED TROTTER AND PATRICIA F. LANIER
Department of Anatomy, Washington University, Saint Louis

THE introduction of continuous caudal analgesia into the field of obstetrics has attracted attention to the form and extent of the sacral hiatus. Although the method of caudal anesthesia has been utilized by surgeons throughout the greater part of the present century a "continuous" caudal administration was made during the period of labor and delivery for the first time in 1941 by Edwards and Hingson (1942). The application of this method of anesthesia has become widespread (Hingson and Edwards, 1943; Southworth and Hingson, 1943; Lull and Hingson, 1944) and with this diversity the importance of a knowledge of the anatomy of the region is emphasized.

The entrance of the anesthetic agent into the sacral canal is made through its hiatus. This aperture has been described in text-books of anatomy as the result of failure of the laminae of the fifth sacral vertebra and sometimes of the fourth to meet in the middle line. It marks the termination of the sacral canal and it is extremely variable in its form and extent; the laminae of all the sacral vertebrae may meet in the middle line resulting in no sacral hiatus, or the laminae of no one of the sacral vertebrae may meet resulting in an incomplete bony dorsal wall of the sacral canal. The sacrum may be altered in its composition as a result of variation in the developmental constitution of the vertebral column. Between these extremes of variation a wide variety of hiatus canalis sacralis with respect to its extent may be seen.

Dieulafé (1905) presented measurements of the sacral hiatus in 28 bones and Bernardbeig (1923) in a series of 113 sacra. Recently, measurements were reported for a series of female bones (Trotter and Letterman, 1944) and for a series of male bones (Letterman and Trotter, 1944) without regard to race. In another study (Lanier, McKnight and

[1] This study was aided by a grant from the United States Public Health Service.

Trotter, 1944) measurements of the hiatus of 53 sacra were made in the recent state and again after skeletonization; no statistically significant difference was obtained. A search of the literature has failed to reveal a study of this aperture in so far as physical anthropology is concerned. In the present instance the sacra of a large series of skeletons have been examined and studied from the standpoint of race, sex, and age with the chief interest being directed at the hiatus of the sacral canal.

MATERIAL

The sacra examined are from the skeletons comprising the Terry Anatomical Collection and the Todd Anatomical Collection[2]. It is well-known that these skeletons are from cadavers received by Washington University and Western Reserve University for the study of anatomy and that the records are taken from the Bureaus of Vital Statistics in St. Louis and Cleveland. Therefore, it is identified material and represents a cross-section of the indigent population of the two cities. All the female sacra of both collections were examined; the male sacra are entirely from the Terry Collection. Since the populations of the two cities are similar in constitution and the methods of preparing the skeletons are also similar, sacra have been separated only according to race, sex and age and not in respect to the collection of which they form a part. Their distribution is shown in Table 1.

METHOD

The composition of the sacrum was ascertained by determining whether it was composed of four, five, six or more vertebrae and which vertebrae these were by number according to the rest of the column. When the coccyx either in part or whole is fused to the sacrum there is often included in the bony union the superficial posterior sacrococcygeal ligaments. Thus, the length of the hiatus is extended. There appears to be no agreement on the question of when the sacrococcygeal symphysis passes into the bony union: Morris' *Human Anatomy* (1942) states that it occurs in advanced age; whereas the age for ankylosis is placed between the 30th and 40th years in Piersol's *Human Anatomy* (1936); and

---

[2] Grateful acknowledgement is made to Dr. Normand L. Hoerr, Professor of Anatomy at Western Reserve University for his kindness in putting the material at our disposal for study.

TABLE 1

Distribution of sacra according to race, sex and age

AGE	AMERICAN WHITE			AMERICAN NEGRO			TOTAL
	Males	Females	Total	Males	Females	Total	
14-19		5	5	5	14	19	24
20-29	4	15	19	40	98	138	157
30-39	8	34	42	50	97	147	189
40-49	46	31	77	61	83	144	221
50-59	62	42	104	38	61	99	203
60-69	94	43	137	42	40	82	219
70-79	68	39	107	15	29	44	153
80-89	14	22	36	5	14	19	53
90-101		2	2		4	4	6
Total	296	233	529	256	440	696	1225
Mean age in years	61.2	54.2	58.8	46.1	43.8	44.7	50.8

Gray's text (1942) suggests that "at a late period of life, especially in females, the coccyx often fuses with the sacrum."

Three measurements in millimeters were undertaken: one, the width of the base of the hiatus, i. e., the distance between the medial sides of the inferior limit of the roots of the sacral cornua or of the coccygeal cornua when the sacral and coccygeal cornua of the same side have fused as a result of the ossification of the superficial posterior sacrococcygeal ligament, using a flexible steel tape; two, the length of the hiatus, i. e., the distance from the mid-point of the base to the apex, using a flexible steel tape; and three, the depth of the hiatus at its apex, i. e., the anteroposterior distance between the apex of the hiatus and the posterior surface of the body of the sacral vertebra opposite which it lay, using a narrow steel rule (see Figs. 1 and 2).

There were noted also the levels (i. e., upper, middle, or lower third) of the particular vertebral bodies at which the apex and base of the hiatus were located.

COMPOSITION OF THE SACRUM

The adult sacrum is a single bone formed by the union of the five sacral vertebrae or of vertebrae 25 through 29 of the column according

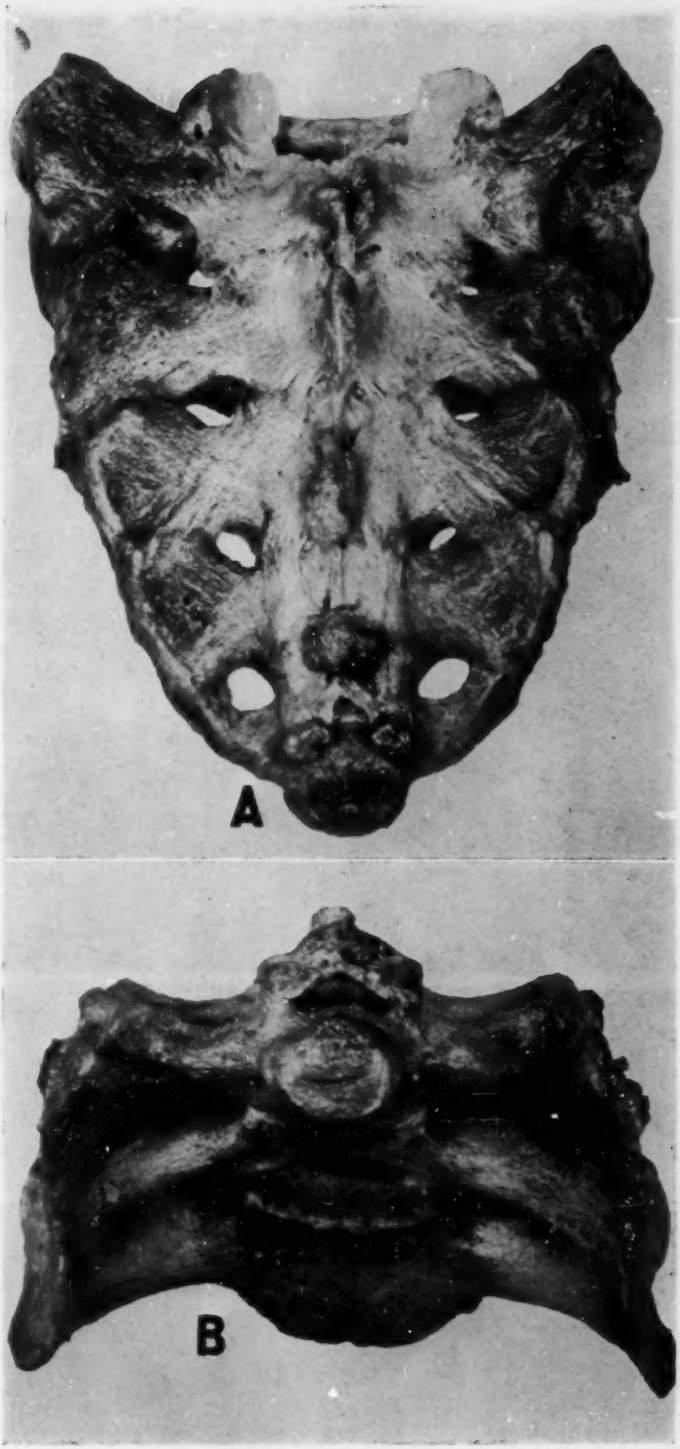

FIG. 1. W. U. #1512. WHITE, FEMALE, 37 YEARS. A. DORSAL VIEW OF TEXT-BOOK TYPE OF SACRUM IN WHICH WIDTH OF BASE AND LENGTH OF HIATUS CANALIS SACRALIS ARE EVIDENT. B. INFERIOR VIEW OF HIATUS SHOWING THE ANTEROPOSTERIOR DIAMETER

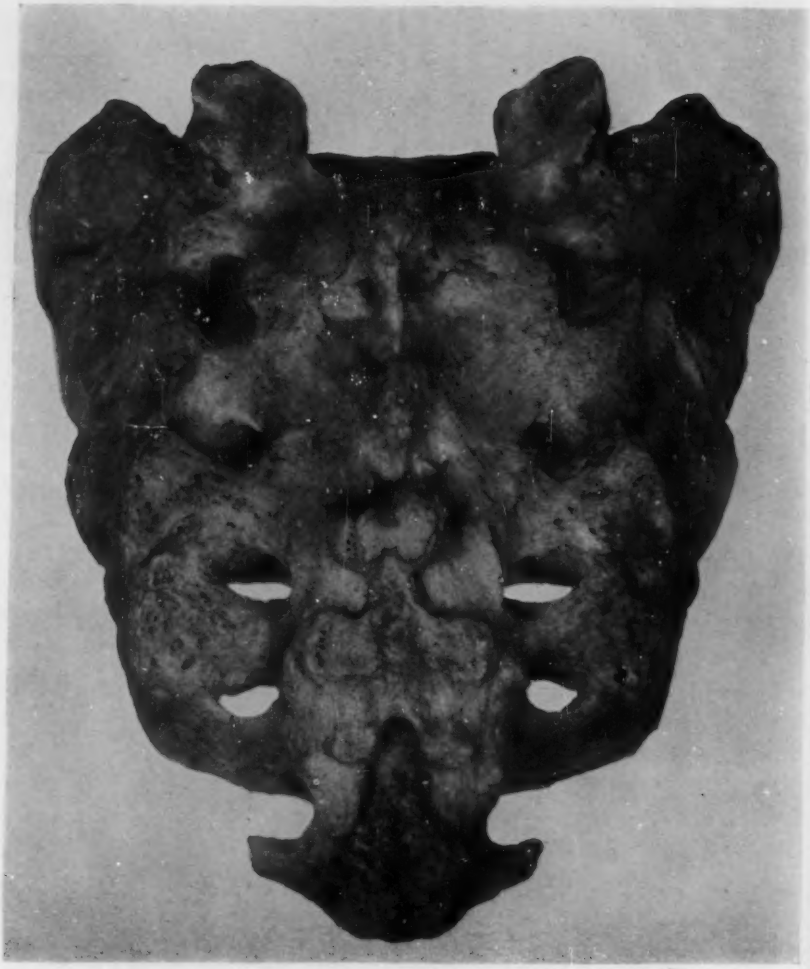

FIG. 2. W. U. #1393. NEGRO, FEMALE, 41 YEARS. SACRUM WITH SACROCOCCYGEAL ARTICULATION ANKYLOSED AND OSSIFICATION OF THE SUPERFICIAL POSTERIOR SACROCOCCYGEAL LIGAMENTS RESULTING IN INCREASED LENGTH OF THE HIATUS

to Terry (1942): "Consolidation begins soon after puberty by fusion of the costal elements and this is followed by ossification caudocranial in the intervertebral disks, resulting in the union of the adjacent bodies and the epiphyseal plates, the ossific union of the first and second being completed by the twenty-fifth year or a little later." Examination of young skeletons in the Terry Collection indicated that the five segments are sufficiently joined by bony union at the age of 14 years to result in a single bone after skeletonization. Thus, we have excluded from this study all bones younger than 14 years.

Not infrequently the fifth lumbar vertebra becomes partially or completely sacralized and is fused to the sacrum. Since this fusion cannot affect the topography of the hiatus of the sacral canal those sacra with the fifth lumbar vertebra fused have been considered in the same group as the typical 5-vertebrae sacrum. Much more commonly is the first coccygeal or the entire coccyx ankylosed to the fifth sacral vertebra. Such a condition may affect the longitudinal extent of the sacral hiatus since the fusion often includes ossification of the superficial posterior sacrococcygeal ligaments which extend between the sacral and coccygeal cornua—thus lengthening the hiatus to the level of the first coccygeal vertebra. Occasionally the sacrum is extended at both the lumbar and coccygeal extremities by fusion of the adjacent vertebrae. In this study, these bones were grouped with those in which there was sacralization of the first or more coccygeal vertebrae since it is variation only at the coccygeal extremity of the sacrum which may have a bearing on the hiatus.

And, finally, there appears rarely a sacrum composed of only four segments. In this series there were eight ranging in age from 22 to 63 years: two were white females; four, Negro females; and two, Negro males. The white male group did not present a single example of the 4-vertebrae sacrum (see Table 2).

It is interesting that the 5-vertebrae sacrum appears in more than 50 per cent of the cases in both sexes of the Negro groups whose average age is 44.7 years and in somewhat less than 50 per cent of the cases in both sexes of the white series who are approximately 15 years older. The high frequency of the fusion of the first or more coccygeal vertebrae to the sacrum warrants an examination of the distribution according to age.

In Table 3 the number of sacra in each successive decade according to race and sex is shown under two headings: *5S* includes those sacra with only five sacral vertebrae and with five sacral and the fifth lumbar, i. e.,

TABLE 2

Composition of the sacra

NUMBER OF SEGMENTS	AMERICAN WHITE				AMERICAN NEGRO				TOTAL	
	Males		Females		Males		Females			
	Number	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per cent*
Four	0	0	2	.9	2	.8	4	.9	8	.7
Five	104	35.1	99	42.5	138	53.9	269	61.1	610	49.8
Five + 5th lumbar	30	10.1	14	6.0	28	10.9	53	12.1	125	10.2
Both	134	45.2	113	48.5	166	64.8	322	73.2	735	60.0
Five + coccygeal	149	50.3	111	47.6	85	33.2	107	24.3	452	36.9
Five + 5th lumbar and coccygeal	13	4.4	7	3.0	3	1.2	7	1.6	30	2.4
Both	162	54.7	118	50.6	88	34.4	114	25.9	482	39.3
Total	296	100.0	233	100.0	256	100.0	440	100.0	1225	100.0

TABLE 3

*Age distribution of 5 segment-sacra with and without fused coccyges**

YEARS	AMERICAN WHITE								AMERICAN NEGRO							
	Males				Females				Males				Females			
	5S		5S+C		5S		5S+C		5S		5S+C		5S		5S+C	
	Number	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*
14-19	0		0		4	80.0	1	20 0	5	100	0		9	64.3	5	35.7
20-29	3	75.0	1	25.0	11	73.3	4	26.7	29	72.5	11	27.5	76	80.9	18	19.1
30-39	5	62.5	3	37.5	15	44.1	19	55.9	35	70.0	15	30.0	68	70.1	29	29.9
40-49	24	52.2	22	47.8	18	60.0	12	40.0	39	66.1	20	33.9	63	75.9	20	24.1
50-59	28	45.2	34	54.8	13	31.0	29	69.0	24	63.2	14	36.8	49	80.3	12	19.7
60-69	48	51.1	46	48.9	19	45.2	23	54.8	23	54.8	19	45.2	26	65.0	14	35.0
70-79	24	35.3	44	64.7	21	53.8	18	46.2	11	73.3	4	26.7	19	65.5	10	34.5
80-89	2	14.3	12	85.7	11	50.0	11	50.0	0		5	100	9	64.3	5	35.7
90-	0		0		1	50.0	1	50.0	0		0		3	75.0	1	25.0
Total	134	45.3	162	54.7	113	48.9	118	51.1	166	65.4	88	34.6	322	73.6	114	26.4

* The number of sacra in this and succeeding tables may show discrepancies when compared with the total number recorded in Table 1 due to insufficient obtainable information.

bones with no alteration in constitution at the coccygeal extremity; $5S+C$ includes those sacra with five sacral vertebrae plus one or more coccygeal vertebrae and, also, those few with fusion at the lumbar extremity occurring simultaneously with fusion at the coccygeal end. For each of the four main subdivisions the number in each decade has been taken as 100 per cent and the sacra according to composition (i. e., $5S$ and $5S+C$) are reduced to percentages. Although the number of specimens in many of the decades is very small there is apparent in the American white male and female groups a trend from the 5-vertebrae sacrum to the sacrum with coccyx fused in passing from the younger to the older groups. Such a trend does not appear in the Negro male and female groups.

Thus the data were analyzed, first, to determine the difference between the races in so far as fusion of the coccyx to the sacrum was concerned. The white male group of $5S$ was compared with the Negro male group of $5S$. The percentage difference between the two was 20.1 (65.4 per cent—45.3 per cent), a difference which, according to the formula[3] for testing the reliability of the difference, was statistically significant, P less than .001. In like manner, the white and Negro female groups were compared and the difference proved to be statistically significant, P again less than .001. It may be concluded, therefore, that the fusion of the coccyx to the sacrum in these skeletons is of a significantly higher incidence in the white male and female groups than in the Negro male and female groups.

Since the average age of the white group is approximately 15 years older than that of the Negro group these data were studied, second, to determine whether or not the racial difference was due to the difference in age. Each group was subdivided into two parts: those under 50 years of age and those 50 years and older. Again the formula for testing the reliability of the difference was employed. The test showed that:

(a) in the white male group those under 50 years of age tended to have a predominance of $5S$ over $5S+C$, whereas those 50 years and older have a predominance of $5S+C$ over $5S$; these differences are not definitely significant, P of .08;

---

[3] The standard formula, $D/\sigma_{diff.}$, has been used for testing the significance of the difference. The larger the value of this ratio, the smaller is the probability, P, that the difference would arise as a result of chance alone. A value of the ratio of 3 corresponds to a P of .0027, that is, for this case there is a small probability that chance would produce the difference, and it may therefore be accepted as reliable. *See* H. E. Garrett: *Statistics in Psychology and Education*, Longmans Green and Co., 1934, pp. 128-134.

(b) in the white female group the differences between *5S* and *5S+C* in the two age groups were significant, P of .04;
(c) in the Negro male group these differences had a P of .04;
(d) in the Negro female group the differences were not significant, P of .30.

It may be interpreted from these figures that in the groups of white females and Negro males there was an increase in fusion of coccyx and sarcum with age; in the white male groups this might questionably be so; but in the Negro females this could not be proved.

When the white males under 50 are compared with the Negro males under 50, it is found that the difference between the percentage of sacra with fused coccyges in the white males and in the Negro males is definitely significant and this difference shows that there is a much larger percentage of fusion in the Negro under 50 than in the white (52.4 per cent—16.0 per cent). Likewise, those 50 years and older show a larger percentage of fusion in the white males than in the Negro males. The same holds true in comparing the white females with the Negro females where there is 30.5 per cent of white females under 50 with fused coccyges and 63.2 per cent of Negro females. One can conclude, therefore, that there is a definite racial tendency for the coccyx to fuse at an earlier age in the Negro than in the white.

Third, similar age groups of the two races for each sex were compared to see whether percentage differences of fusion as shown in the total figures discussed previously were true in each of the two age groups. The percentage of *5S* in the white males under 50 was 55 per cent and in the Negro males 70 per cent. The difference in the two percentages is significant, P equaling .02. Likewise, in those over 50 the white males had only 43 per cent of *5S* and the Negro males had 58 per cent of *5S*, a difference of 15 per cent which is also significant, to the same level. Comparable percentage differences were obtained in the female groups—18 per cent more *5S* in Negroes under 50 than in whites and 28 per cent more *5S* in Negroes over 50 than in whites, and these differences were also significant. Thus, one may conclude that in each age group the fusion of the sacrum is definitely of greater incidence in the white males and females than in the Negro males and females.

BASE OF HIATUS

The base of the sacral hiatus was found to be as far cephalad as the level of the upper third of the body of the 4th sacral vertebra in five

cases and as far caudad as the middle third of the body of the 1st coccygeal vertebra in twenty-five bones (see Table 4). The remaining 1181 sacra presented the base of the hiatus at a level somewhere between these two extremes, with the highest incidence falling at the level of the upper third of the body of the 5th sacral vertebra; 70 per cent of the total presented the base at the level of the body of the 5th sacral vertebra and 29 per cent in relation to the 1st coccygeal, leaving only 1 per cent of bones whose hiatus did not extend caudally beyond the level of the body of the 4th sacral vertebra.

TABLE 4

Vertebral level of the base of the hiatus

VERTEBRAE (IN THIRDS)		AMERICAN WHITE		AMERICAN NEGRO		TOTAL
		Males	Females	Males	Females	
4th Sacral	Upper	0	0	1	4	5
	Middle	0	2	1	5	8
	Lower	1	1	0	4	6
5th Sacral	Upper	83	89	122	169	463
	Middle	74	35	63	164	336
	Lower	3	21	2	17	43
1st Coccygeal	Upper	114	81	58	72	325
	Middle	13	1	7	4	25
	Total	288	230	254	439	1211

Of those sacra with part or all of the coccyx fused, 73 per cent presented the inferior limit of the hiatus at the level of the 1st coccygeal vertebra which is the natural sequence of ossification of the superficial posterior sacrococcygeal ligaments.

The range, mode, median, mean and standard deviation (in mm.) of the width of the base of the hiatus were found to be as shown in Table 5. Thus, among the four groups there was a divergence of only 1.7 mm. in the mean width of the base, but a range from 8 mm. to 28 mm.

The width of the base in the white groups shows a tendency to gradually increase as the base is found to be more cephalad—in other words the base is somewhat narrower when found at the level of the body of

TABLE 5

Constants describing width of base of hiatus (in mm.)

GROUP	RANGE	MODE	MEDIAN	MEAN	S. D.
White males	8-26	17	16	16.6±.1	2.8
White females	8-23	15	16	15.9±.1	2.9
Negro males	10-25	18	17	17.6±.1	2.4
Negro females	8-28	18	17	17.0±.1	2.5

the 1st coccygeal vertebra than when it occurs at the level of the body of the 5th sacral vertebra. Such a tendency does not obtain in the Negro groups. The coefficients of correlation between the level of the base and the width of the base of the hiatus were: white males, +.47±.03; white females, + .60 ± .03; Negro males, + .26 ± .04; and Negro females, +.21±.03.

LENGTH OF HIATUS

The mean length of the hiatus was shortest in the Negro females (17.7 mm.) and longest in the white males (24.8 mm.). In both racial groups the males presented hiatuses with significantly longer mean lengths than did the females and for the same sexes of the two races the whites exceeded the Negroes significantly. This result is entirely compatible with the higher incidence of fusion of the coccyx to the sacrum in whites than in Negroes.

The length of the hiatus in these series of sacra presented no real difference between the groups of *5S* and *5S+C* in composition when the base in the second group fell on a level with the sacrum, as indicated in Table 6. On the other hand in the *5S+C* group when the base fell on a level with the coccyx the length of the hiatus was approximately 15 per cent or more longer for each of the subdivisions excepting the Negro female where it exceeded by only 10 per cent.

The coefficients of correlation between the level of the base and the length of the hiatus are as follows: white males, —.31±.03; white females —.27±.04; Negro males, —.14±.04; and Negro females, —.20±.03. There is indicated only to a very slight extent that the lower the base is located the longer will be the hiatus and this indication is even less among the Negroes than among the whites.

The sacra of this series in which no pairs of laminae meet in the

TABLE 6

*Mean length of hiatus (in mm.)**

COMPOSITION OF SACRUM	AMERICAN WHITE		AMERICAN NEGRO	
	Males	Females	Males	Females
5S (726)	22.8 (131) 3-53	18.8 (112) 0-45	18.7 (165) 0-58	17.0 (318) 0-55
5S+C (128) (base on sacrum)	21.0 (32) 5-47	19.8 (34) 4-48	17.4 (22) 6-35	18.0 (40) 3-33
5S+C (350) (base on 1st C)	27.9 (125) 6-60	24.1 (84) 8-65	22.9 (65) 11-46	20.2 (76) 7-33
Total (1204)	24.8±.1 (288)	19.8±.1 (230)	19.7±.1 (252)	17.7±.1 (434)
Standard Deviation	2.1	1.62	2.1	1.7

* The figures in parentheses indicate the number of sacra examined for each group; the hyphenated figures indicate the range of lengths in millimeters.

middle line resulting in a completely open bony dorsal wall of the sacral canal are 13, ranging in age from 17 to 80 years. They may be summarized as follows: 8 white males, 2.7 per cent; 1 white female, .4 per cent; 2 Negro males, 1.2 percent; and 1 Negro female, .2 per cent. The incidence of this variation is almost negligible, one per cent in a series of 1225 bones. However, its marked concentration in the males and its appearance twice as frequently in the white groups as in the Negroes suggests both a racial and sexual difference.

APEX OF HIATUS

The apex of the hiatus is found at vertebral levels extending from the upper third of the body of the 2nd sacral vertebra to the lower third of the body of the 5th sacral vertebra. The distribution according to race and sex is summarized in Table 7.

The body of the 4th sacral vertebra marks the level of the apex in approximately 65 per cent of the entire group and also of each of the subdivisions. In from 15 per cent to 20 per cent of each subdivision the apex does not extend beyond the body of the 5th sacral vertebra and in the remainder it reaches the level of the body of the 3rd sacral or even of the 2nd sacral.

TABLE 7

Vertebral level of apex of hiatus

VERTEBRAE (IN THIRDS)		AMERICAN WHITE Males	AMERICAN WHITE Females	AMERICAN NEGRO Males	AMERICAN NEGRO Females	TOTAL
2nd Sacral	Upper	1				1
	Middle	1				1
	Lower	1		2	2	5
3rd Sacral	Upper	4	5	4	2	15
	Middle	9	11	6	11	37
	Lower	37	23	24	57	141
4th Sacral	Upper	55	31	43	60	189
	Middle	49	40	33	63	185
	Lower	89	79	87	159	414
5th Sacral	Upper	30	27	43	65	165
	Middle	7	13	11	13	44
	Lower	5	2	2	7	16
	Total	288	231	255	439	1213

The range, mode, median, mean and standard deviation (in mm.) of the anteroposterior distance between the apex of the hiatus and the posterior surface of the body of the sacral vertebra opposite which it lay were found to be as given in Table 8. Thus, among the four groups there was a mean difference of 1.1 mm. or of 20 per cent of the largest mean measurement. The means of the Negroes exceeded significantly

TABLE 8

Constants (in mm.) describing the anteroposterior distance between the apex of the hiatus and the posterior surface of the body of the sacral vertebra opposite which it lay

GROUP	RANGE	MODE	MEDIAN	MEAN	S.D.
White males	0–12	5	5	4.9±.1	1.5
White females	0–10	4	4–5	4.6±.1	1.7
Negro males	2–11	6	5–6	5.6±.1	1.7
Negro females	0–16	6	6	5.7±.1	1.9

those of the whites. There was no correlation between the level of the apex and the anteroposterior diameter of the hiatus; for each of the groups the coefficient was .1 or less.

SUMMARY

The extent of the hiatus canalis sacralis was studied in a series of 1225 white and Negro bones.

1. Ankylosis of the first coccygeal vertebra or of the entire coccyx to the sacrum (a condition which may affect the extent of the hiatus) occurs significantly more often in whites than in Negroes; it occurs at an earlier age in Negroes than in whites; and its incidence increases with age significantly in white females and in Negro males.
2. The base of the hiatus lies at the level of the body of the fifth sacral vertebra in 70 per cent and at the level of the body of the first coccygeal vertebra in 29 per cent of the bones examined. When the coccyx is fused to the sacrum 73 per cent present the base of the hiatus at the level of the body of the first coccygeal vertebra. The mean width varies from 15.9 mm. in the white females to 17.6 mm. in the Negro males. In the whites, but not in the Negroes, there is a tendency for the width of the base to increase as the base is found to be more cephalad.
3. The hiatus is longer in whites than in Negroes, in males than in females, and in those sacra where the base lies on a level with the coccyx rather than with the sacrum.
4. The apex of the hiatus lies at the level of the body of the fourth sacral vertebra in 65 per cent of all the bones; the remaining 45 per cent are approximately equally divided between higher and lower levels. The anteroposterior diameter of the hiatus at its apex is significantly greater in Negroes than in whites.

LITERATURE CITED

BERNARDBEIG, J. 1923. Situation et morphologie de l'hiatus sacralis. *Arch. d'anat., d'hist. et d'emby.*, II, pp. 521-535.

DIEULAFÉ, L. 1905. Topographie de l'hiatus sacré. *Le Bull. Mèd.*, XIX, pp. 781-782.

EDWARDS, WALDO B. and ROBERT A. HINGSON. 1942. Continuous caudal anesthesia in obstetrics. *Am. J. Surg.*, LVII, pp. 459-465.

GRAY's Anatomy of the Human Body. 1942. XXIV ed. Edited by Warren H. Lewis, Lea and Febiger, 1428 pp.

HINGSON, ROBERT A. and WALDO B. EDWARDS. 1943. Continuous caudal analgesia in obstetrics. *J. Am. Med. Ass.*, CXXI, pp. 225-229.

LANIER, VIRGINIA SINGLETON, HOWARD E. MCKNIGHT and MILDRED TROTTER. 1944. Caudal analgesia: an experimental and anatomical study. *Am. J. Obst. and Gynec.*, XLVII, pp. 633-641.

LETTERMAN, GORDON S. and MILDRED TROTTER. 1944. Variations of the male sacrum. *Surg. Gynec. and Obst.*, LXXVIII, pp. 551-555.

LULL, CLIFFORD B. and ROBERT A. HINGSON. 1944. Control of pain in childbirth. J. B. Lippincott Co., 356 pp.

MORRIS' Human Anatomy. 1942. X ed. Edited by J. Parsons Schaeffer, Blakiston Co., 1635 pp.

PIERSOL's Human Anatomy. 1936. IX ed. Edited by G. Carl Huber, J. B. Lippincott Co., 2104 pp.

SOUTHWORTH, JAMES L. and ROBERT A. HINGSON. 1943. Continuous caudal analgesia in surgery. *Ann. Surg.*, CXVIII, pp. 945-971.

TERRY, R. J. 1942. The articulations. Section IV in Morris' *Human Anatomy*, X ed., pp. 266-377.

TROTTER, MILDRED and GORDON S. LETTERMAN. 1944. Variations of the female sacrum. *Surg. Gynec. and Obst.*, LXXVIII, pp. 419-424.

RECENT LITERATURE*

USEFUL IN THE STUDY OF HUMAN BIOLOGY

I. EVOLUTION AND GENETICS

1. *Evolution — General Principles*

[Vacant]

2. *Human Evolution*

[Vacant]

3. *Prehistory and Archaeology*

PEAKE, HAROLD J. E. The earliest structure at Stonehenge. *Man*, 45: 74-78, 1945. [Bibliography of 15 titles.]

WEIDENREICH, FRANZ. The Paleolithic child from the Teshik-Tash Cave in Southern Uzbekistan (Central Asia.) *Am. J. Phys. Anthropol.*, 3 (n. s.): 151-162 + 1 plate, 1945. [Bibliography of 21 titles.]

4. *Genetics — General Principles*

OSORIO TAFALL, BIBIANO F. Genética y mejoramiento humano. *Bol. de la Escuela Nacional de Ciencias Biologicas*, no. 3: p. 15, August, 1941.

5. *Human Heredity*

KLOEPFER, H. WARNER. An investigation of 171 possible linkage relationships in man. *Abstracts of Doctoral Dissertations*, 39: 221-228, 1943.

SCHULTZ, JACK. Genetic factors in cancer. *Clinics*, 4: 118-127, 1945. [Bibliography of 18 titles.]

SNYDER, LAURENCE H. Studies in human inheritance. XXII. The inheritance of congenital pyloric stenosis. *Ohio J. Science*, 43: 49-50, 1943. [1 reference.]

SNYDER, LAURENCE H. and DWIGHT M. PALMER. Studies in human inheritance. XXIII. An idiopathic convulsive disorder with deterioration apparently dependent upon an incompletely sex-linked gene. *J. Hered.*, 34: 207-212, 1943. [Bibliography of 8 titles.]

---

* NOTE:—With the increase in reference facilities to biological literature through such journals as *Biological Abstracts, Population Index*, etc., the editors of HUMAN BIOLOGY feel that the section on RECENT LITERATURE does not fill the need that it did at the time it was inaugurated. They have therefore decided to discontinue this feature of the Journal with this issue.

SNYDER, LAURENCE H. and FRITZ BLANK. Studies in human inheritance. XXIV. Bridged sella as a genetic trait. *Ohio State M. J.*, 40: 318-320, 1944. [Bibliography of 7 titles.]

SNYDER, LAURENCE H. and CHARLES A. DOAN. Studies in human inheritance. XXV. Is the homozygous form of multiple telangiectasia lethal? *J. Lab. and Clin. Med.*, 29: 1211-1216 + 1 plate, 1944. [Bibliography of 17 titles.]

SNYDER, LAURENCE H., MURRAY D. SCHONFELD, and EDITH M. OFFERMAN. Studies in human inheritance. XXVI. The Rh factor and feeble-mindedness. *J. Hered.*, 36: 9-10, 1945. [Bibliography of 6 titles.]

SNYDER, LAURENCE H. and FRITZ BLANK. Studies in human inheritance. XXVII. The inheritance of the shape of the sella turcica. *J. Science*, 45: 13-15, 1945. [Bibliography of 5 titles.]

6. *Eugenics*

[Vacant]

II. GROUP BIOLOGY

1. *Environment of Man*

BATES, MARSTON. The forest and the sea. *Scient. Monthly*, 60: 383-387, 1945.

HIGBEE, E. C. The river is the plow. *Scient. Monthly*, 60: 405-416, 1945.

2. *Public Health and Hygiene*

ADAMS, JAMES M. Stanacola medical care plan. *J. A. M. A.*, 126: 333-335, 1944.

BLOOM, M. S. Variations in current industrial medical service plans. *J. A. M. A.*, 126: 335-337, 1944.

BURKE, WILLIAM J. Control of health hazards in the industrial handling of chemicals. *Indust. Bull. and Employ. Rev.*, 24: 207-217, 1945. [Bibliography of 19 titles.]

DOWNES, JEAN. Sickness as an index of the need for health supervision of the school child. *Am. J. Pub. Health*, 35: 593-601, 1945. [Bibliography of 5 titles.]

DOWNES, JEAN and ANNE BARANOVSKY. An experiment in nutrition teaching by public health nurses. *Milbank Mem. Fund Quart.*, 23: 227-253, 1945. [Bibliography of 3 titles.]

EMERSON, HAVEN, in collaboration with MARTHA LUGINBUHL. Local Health Units for the Nation. *New York* (Commonwealth Fund), 1945. Pp. vii + 333. 10¾ × 8¼ inches. $1.25.

GARFIELD, SIDNEY R. Health plan principles in the Kaiser industries. *J. A. M. A.*, 126: 337-339, 1944.

GIRAL, FRANCISCO and JOSÉ VÁZQUEZ SÁNCHEZ. Sobre un supuesto influjo del calcio en la intoxicacion por el tetracloruro de carbono. *Medicina*, 20: p. 158, March, 1940.

JONES, EDWARD M. Endicott-Johnson medical plan. *J. A. M. A.*, 126: 339-341, 1944.

KNOWLES, FREDERICK L. and FRANK W. FISK. DDT water emulsion in rice fields as a method of controlling larvae of *Anopheles quadrimaculatus* and other mosquitoes. *Pub. Health Rep.*, 60: 1005-1019 + 1 plate, 1945. [Bibliography of 3 titles.]

LARIMORE, GRANVILLE W. and THOMAS H. STERNBERG. Does health education prevent venereal disease? *Am. J. Pub. Health*, 35: 709-804, 1945.

MCCANN, JAMES C. Medical society prepayment progr. Lessons learned from experience in Massachusetts. *J. A. M. A.*, 126: 341-343, 1944.

METCALF, R. L., A. D. HESS, G. E. SMITH, G. M. JEFFERY, and G. W. LUDWIG. Observations on the use of DDT for the control of *Anopheles quadrimaculatus*. *Pub. Health Rep.*, 60: 753-774 + 4 plates, 1945. [Bibliography of 4 titles.]

MUSTARD, HARRY S. Government in Public Health. *New York* (Commonwealth Fund), 1945. Pp. xx + 219. 8½ × 5⅝ inches. $1.50. [References at end of each chapter.]

NEW HAMPSHIRE STATE DEI 'R.MENT OF HEALTH. Twenty-fourth Biennial Report, 1943-1944. *Concord* (State Department of Health), 1944. Pp. 92. 9¼ × 6 inches.

PRICE, MILTON M. and F. EARLE LYMAN. Second report on the control of *Anopheles quadrimaculatus* Say in the water-chestnut areas of the Potomac River, 1944. *Pub. Health Rep.*, 60: 985-994, 1945. [1 reference.]

ROEMER, MILTON I. A program of preventive medicine for the individual. *Milbank Mem. Fund Quart.*, 23: 209-226, 1945.

RUMREICH, A. S. and R. S. WYNN. A study of the rodent-ectoparasite population of Jacksonville, Florida. *Pub. Health Rep.*, 60: 885-905, 1945. [Bibliography of 40 titles.]

SAYÉ, LUIS. Doctrina y práctica de la profilaxis de la tuberculosis. *Anales del Departamento científico de Salud Pública de Uruguay. Montevideo* (Departamento científico de Salud Publica, 1939.)

SIMMONS, S. W. Tests of the effectiveness of DDT in anopheline control. *Pub. Health Rep.*, 60: 917-927, 1945. [1 reference.]

SMILLIE, W. G. Certain defects of a nation-wide plan for provision of adequate medical care. *J. A. M. A.*, 128: 1003-1005, 1945. [3 bibliographic footnotes.]

WYATT, S. A Study of Women on War Work in Four Factories. *London* (H. M. Stationery Office), 1945. *Medical Research Council, Industrial Research Board Report No.* 88. Pp. 44. 9⅝ × 6 inches. 9d.

3. *Migration*

BUREAU OF THE CENSUS. *Population — Special Reports. Washington, D. C.* Series P-S, No. 5. Civilian migration in the United States: December, 1941 to March, 1945. September 2, 1945. Pp. 8.

4. *Population*

BUREAU OF THE CENSUS. *Vital statistics — Special Reports. Washington, D. C.* Volume 23, selected studies, No. 3. Demographic status of South America. September 18, 1945. Pp. 63-78.

OFFICE OF INTER-AMERICAN AFFAIRS. Handbook of Latin American Population Data. Populations of the Other American Republics by Major Civil Divisions and by Cities of 5,000 or More Inhabitants. *Washington*, (U. S. Govt. Printing Office), 1945. Pp. vi + 58. 9⅛ × 6 inches. [References throughout.]

5. *Mortality and General Vital Statistics*

BUREAU OF THE CENSUS (Or OFFICE OF THE COORDINATOR OF INTER-AMERICAN AFFAIRS). Summary of Biostatistics: Maps and Charts, Population, Natality, and Mortality Statistics. *Washington* (Bureau of the Census), 1945. Various volumes as follows:

Haiti. 10½ × 8 inches. Pp. 72.
Cuba. 10½ × 8 inches. Pp. 113.
Nicaragua. 10½ × 8 inches. Pp. 89.
Panama. 10½ × 8 inches. Pp. 81.

BUREAU OF THE CENSUS. *Vital Statistics — Current Mortality Analysis. Washington, D. C.* Discussion of returns from a 10 per cent sample of death certificates received in vital statistics offices. Vol. 3: Various numbers as follows:
5. May 1945. July 27, 1945. Pp. 4.
6. June 1945. August 25, 1945. Pp. 4.

CHILDREN'S BUREAU. *Social Statistics. Changes in volume of health and welfare services*: 1940-42. *Washington, D. C.* (U. S. Government Printing Office). (Supplement to Vol. 9, No. 4 (October, 1944) of *The Child.*) Pp. 22.

COLLINS, SELWYN D. Influenza and pneumonia excess mortality at specific ages in the epidemic of 1943-44, with comparative data for preceding epidemics. (First part). *Pub. Health Rep.*, 60: 821-835, 1945. [Bibliography of 21 titles.]

COLLINS, SELWYN D. Influenza and pneumonia excess mortality at specific ages in the epidemic of 1943-44, with comparative data for preceding epidemics. (concluded). *Pub. Health Rep.*, 60: 853-863, 1945.

DOULL, JAMES A. Tuberculosis mortality in England and certain other countries during the present war. *Am. J. Pub. Health*, 35: 783-787, 1945. [Bibliography of 4 titles.]

FREITAS FILHO, LINCOLN DE. O problema da seleção da causa primária do óbito no Brasil. *Arquivos de Higiene*, 14: no. 3, 7-107, 1944.

MALOON, MARIAN G. [Ed.] State Department of Health of New Hampshire. Thirty-ninth Report of Division of Vital Statistics, 1942-1943. *Concord* (State Department of Health), 1944. Pp. 153. 9⅛ × 6 inches.

VENEZUELA, DIRECCION GENERAL DE ESTADISTICA. VII Censo Nacional De Poblacion. Tomo I. *Caracas, Venezuela*, 1944. Pp. cxxxv + 270. 13 × 9¾ inches.

YERUSHALMY, JACOB and CHARLOTTE SILVERMAN. Tuberculosis mortality in communities of different size. *Am. Rev. Tuberculosis*, 51: 413-431, 1945. [2 references.]

6. *Morbidity and Epidemiology*

BIGG, EDWARD, B. H. JENNINGS, and F. C. W. OLSON. Epidemiologic observations on the use of glycol vapors for air sterilization. *Am. J. Pub. Health*, 35: 788-798, 1945. [Bibliography of 11 titles.]

DAUER, C. C. Incidence of poliomyelitis in the United States in 1944. *Pub. Health Rep.*, 60: 633-642, 1945. [Bibliography of 4 titles.]

DILLON, ANN, R. S. GASS, W. W. HUBBARD, and E. F. HARRISON. Results of the high school tuberculosis program in Tennessee. *J. Tennessee M. A.*, 38: 97-105 + 2 maps, 1945. [Bibliography of 10 titles.]

DONALDSON, ALAN W. The prevalence of pinworm infection in an Ohio institution for children. *J. Parasitol.*, 29: 298-299, 1943.

FAN, J. H. Communicable diseases in China during recent years. *Epidemiol. Inform. Bull.*, 1: 495-521, 1945. [Bibliography of 38 titles.]

FRANCIS, THOMAS, JR. The development of the 1943 vaccination study of the commission on influenza. *Am. J. Hyg.*, 42: 1-11, 1945. [Bibliography of 16 titles.]

GELLIS, SYDNEY S., JOSEPH STOKES, JR., GEORGE M. BROTHER, WILLIAM M. HALL, HUGH R. GILMORE, EMIL BEYER, and RICHARD A. MORRISSEY. The use of human immune serum globulin (gamma globulin) in infectious (epidemic) hepatitis in the Mediterranean theater of operations. *J. A. M. A.*, 128: 1062-1063, 1945. [4 bibliographic footnotes.]

HINES, EDGAR A. and NORMA A. CHRISTENSEN. Raynaud's disease among men. *J. A. M. A.*, 129: 1-4, 1945. [7 bibliographic footnotes.]

JELLISON, W. L. The geographical distribution of Rocky Mountain spotted fever and Nuttall's cottontail in the western United States. *Pub. Health Rep.*, 60: 958-961, 1945. [Bibliography of 6 titles.]

KOHLS, GLEN M., CHARLES A. ARMBRUST, EDWIN N. IRONS, and CORNELIUS B. PHILIP. Studies on tsutsugamushi disease (scrub typhus, mite-borne typhus) in New Guinea and adjacent islands: further observations on epidemiology and etiology. *Am. J. Hyg.*, 41: 374-396, 1945. [Bibliography of 14 titles.]

MOORE, ROBERT A. Medical internationalism. *Scient. Monthly*, 61: 173-180, 1945.

NEEFE, JOHN R. and JOSEPH STOKES, JR. An epidemic of infectious hepatitis apparently due to a water-borne agent. Epidemiologic observations and transmission experiments in human volunteers. *J. A. M. A.*, 128: 1063-1075, 1945. [26 bibliographic footnotes.]

OKLAHOMA STATE HEALTH DEPARTMENT. Public Health Statistics, State of Oklahoma, 1944. Part I. Communicable Diseases. *Oklahoma City* (Oklahoma State Health Department), 1945. Pp. iv + 8. 10⅞ × 8½ inches.

PUFFER, RUTH R., H. C. STEWART and R. S. GASS. Tuberculosis according to age, sex, family history and contact. *Am. Rev. Tuberculosis*, 51: 295-311, 1945. [Bibliography of 8 titles.]

REIMANN, HOBART A., JOHN H. HODGES, and ALISON H. PRICE. Epidemic diarrhea, nausea and vomiting of unknown cause. *J. A. M. A.*, 127: 1-6, 1945. [20 bibliographic footnotes.]

SAPERO, JAMES J. and FRED A. BUTLER. Highlights on epidemic diseases occurring in military forces in the early phases of the war in the South Pacific. *J. A. M. A.*, 127: 502-506, 1945. [12 bibliographic footnotes.]

STOWMAN, KNUD. International quarantine diseases. *Epidemiol. Inform. Bull.*, 1: 551-561, 1945.

STUART, G. Relapsing fever in North Africa and Europe, 1943-1945. *Epidemiol. Inform. Bull.*, 1: 453-464, 1945.

VAN RAVENSWAAY, ARIE C. The geographic distribution of hemolytic streptococci. *J. A. M. A.*, 126: 486-490, 1944. [6 bibliographic footnotes.]

WISCONSIN STATE BOARD OF HEALTH. Accidental Deaths—Their Cause and Prevention. *Madison* (Wisconsin State Board of Health), 1945. Pp. 16. 10⅝ × 8¼ inches.

7. *Natality, Fecundity, Fertility*

CIOCCO, ANTONIO and MARION E. ALTENDERFER. Birth statistics as an index of interdependence of counties with regard to medical services. *Pub. Health Rep.*, 60: 973-985, 1945. [Bibliography of 5 titles.]

SPELLBERG, M. A. and WILLIAM A. LEFF. The incidence of diabetes mellitus and glycosuria in inductees. *J. A. M. A.*, 129: 246-250, 1945. [16 bibliographic footnotes.]

WHELPTON, P. K. and CLYDE V. KISER. Social and psychological factors affecting fertility. III. The completeness and accuracy of the household survey of Indianapolis. *Milbank Mem. Fund Quart.*, 23: 254-296, 1945. [Some bibliographic footnotes.]

8. *Birth Control*

[Vacant]

9. *Marriage and Divorce*

BUREAU OF THE CENSUS. *Population — Special Reports. Washington, D. C.* Series PM-3. Various numbers as follows:

6. Marriage licenses issued in cities of 100,000 inhabitants or more: June, 1945. July 31, 1945. Pp. 2.
7. Marriage licenses issued in cities of 100,000 inhabitants or more: July, 1945. August 31, 1945. Pp. 2.

III. BEHAVIOR

1. *Racial and Genetic Psychology*

BARACH, ALVAN L., RICHARD M. BRICKNER, D. EWEN CAMERON, IVES HENDRICK, JOHN A. P. MILLET, and LAWSON G. LOWREY. Germany after the war. Round table—1945. *Am. J. Orthopsychiat.*, 15: 381-441, 1945.

BULLEN, ADELAIDE KENDALL. A cross-cultural approach to the problem of stuttering. *Child Development*, 16: Nos. 1-2, 1-88, 1945. [Bibliography of 33 titles.]

CUATRECASAS, JUAN. Psicobiologia del Lenguaje. Monografias Medicas "Balmis." *Mexico*, 1940. Pp. 171.

2. *Individual Psychology*

AMES, LOUISE BATES. Free drawing and completion drawing: a comparative study of preschool children. *J. Genet. Psychol.*, 66: 161-165, 1945. [Bibliography of 7 titles.]

BARTLETT, FRANCIS. Recent trends in psychoanalysis. *Science and Soc.*, 9: 214-231, 1945.

BARTLEY, S. HOWARD and ELOISE CHUTE. A preliminary clarification of the concept of fatigue. *Psychol. Rev.*, 53: 169-174, 1945.

CARLTON, THEODORE, and LILYN E. CARLTON. Errors in the oral language of mentally defective adolescents and normal elementary school children. *J. Genet. Psychol.*, 66: 183-220, 1945. [Bibliography of 19 titles.]

SPENCE, KENNETH W. An experimental test of the continuity and non-continuity theories of discrimination learning. *J. Exper. Psychol.*, 35: 253-266, 1945. [Bibliography of 19 titles.]

3. *Psychiatry*

BUTSCH, WINFIELD L. and JAMES C. HARBERSON. Importance of careful selection of soldiers for ligation of varicose veins. *Bull. U. S. Army M. Dept.*, 4: 226-230, 1945.

CUNNINGHAM, JAMES M. The development of psychiatric service in the general hospital and its relation to the veteran. *Am. J. Orthopsychiat.*, 15: 463-471, 1945. [Bibliography of 21 titles.]

LAFORA, GONZALO R. La concepción moderna del criminal nato (factores hereditarios o individuales y factores mesologicos, ambientales o sociales de la criminalidad). *Ciencia*, 2: p. 241, 1941.

4. *History and Biography*

ERLANGER, JOSEPH. William Henry Howell, 1860-1945. *Science*, 101: 575-576, 1945.

RUDISILL, HILLYER, JR. Simon Baruch, M. D. July 29, 1840—June 4, 1921. *Library Bull. Med. Coll. State of South Carolina*, Special Issue (Baruch Number), September, 1944. Pp. 1-8.

5. *Sociology, Law, Politics, and Religion*

IRONS, ERNEST E. Epochs in medicine. The improvement of medical service to labor. *J. A. M. A.*, 127: 621-624, 1945. [1 reference.]

JIMÉNEZ DE ASÚA, LUIS. Alcoholismo y criminalidad. *Criminalia*, 7: No. 8, p. 471, April, 1941.

JIMÉNEZ DE ASÚA, LUIS. Psicoanálisis y delincuencia. *Anales de la Universidad de Santo Domingo*, 7: No. 1, p. 80, January-March, 1943.

MANN, STUART E. Language problems in post-war Europe. *Man*, 45: 78-82, 1945.

MILLS, C. WRIGHT. The powerless people: the social role of the intellectual. *Am. A. Univ. Professors Bull.*, 31: 231-243, 1945.

ROTMAN, D. B. Alcoholism. A social disease. *J. A. M. A.*, 127: 564-567, 1945. [15 bibliographic footnotes.]

6. *Economics*

ALTMEYER, A. J. Greater equity in public assistance financing. *Soc. Sec. Bull.*, 8: No. 6: 3-6, 1945.

BUREAU OF THE CENSUS. *Housing — Special Reports. Washington, D. C.* Series H-45. Various numbers as follows:

2. Characteristics of occupied dwelling units, for the United States: October 1944. July 21, 1945. Pp. 10.
3. Characteristics of homes built in 1935 to 1940, for selected areas: 1940. August 14, 1945. Pp. 9.

BUREAU OF THE CENSUS. *The Labor Force. Washington, D. C.* Various numbers as follows:

37. Estimates of labor force, employment and unemployment in the United States during the week of June 3-9, 1945. July 12, 1945. Pp. 4.
38. Estimates of labor force, employment and unemployment in the United States during the week of July 8-14, 1945. August 15, 1945. Pp. 4.
39. Estimates of labor force, employment and unemployment in the United States during the week of August 5-11, 1945. September 20, 1945. Pp. 5.

BUREAU OF THE CENSUS. *The Labor Force Bulletin. Washington, D. C.* No. 6. Employment and unemployment among veterans of World War II. July, 1945. Pp. 26.

BUREAU OF THE CENSUS. *State Finances*: 1944. *Washington, D. C.* Various issues of Volume 1, Individual state reports, as follows:

1. West Virginia. May 1945. Pp. 9.
2. Alabama. May 1945. Pp. 10.
3. Arizona. May 1945. Pp. 8.
4. Nevada. June 1945. Pp. 9.
5. Maryland. June 1945. Pp. 9.
6. Connecticut. June 1945. Pp. 9.
7. Utah. June 1945. Pp. 9.
8. Missouri. June 1945. Pp. 8.
9. Florida. June 1945. Pp. 8.
10. Iowa. June 1945. Pp. 9.
11. Rhode Island. June 1945. Pp. 9.
12. Pennsylvania. June 1945. Pp. 11.
13. Indiana. September 1945. Pp. 9.
14. Nebraska. September 1945. Pp. 8.
15. Kansas. September 1945. Pp. 8.
16. South Carolina. September 1945. Pp. 9.
17. Minnesota. September 1945. Pp. 9.

BUREAU OF THE CENSUS. *State Finances*: 1944. *Washington, D. C.* Volume 2: Topical Reports. Number 3 (final). Balances in state general, highway, and postwar-reserve funds in 1944. June 1945. Pp. 12.

BUREAU OF THE CENSUS. *State Finances*: 1945. *Washington, D. C.* Volume 2, Topical Reports, Number 2. Preliminary. State Tax collections in 1945. August 1945. Pp. 12.

DOWLING, ELEANOR. The business of government. *Science and Soc.*, 9: 193-213, 1945. [Many bibliographic footnotes.]

OSTROVITIANOV, K. Basic laws of development of socialist economy. *Science and Soc.*, 9: 232-251, 1945. [12 bibliographic footnotes.]

WOODWARD, ELLEN S. What social security can mean to the South. *Soc. Sec. Bull.*, 8: No. 7: 2-6, 1945.

7. *Education*

ALILUNAS, LEO J. Needed research in teacher mental hygiene. *J. Educ. Research*, 38: 653-665, 1945. [Bibliography of 42 titles, + 43 bibliographic footnotes.]

BRETT, AXEL. Instrumentalism and the humanities. *Am. A. Univ. Professors Bull.*, 31: 181-188, 1945.

CARTER, BOYD G. Is education limitation? *Am. A. Univ. Professors Bull.*, 30: 331-345, 1944.

HAMOR, WILLIAM A. Human aspects of scientific research. *Science*, 102: 237-241, 1945.

HARRELL, GEORGE T. and HERBERT M. VANN. Correlation of the medical curriculum. *J. A. Am. M. Coll.*, 20: 139-146, 1945.

ILLINOIS STATE ACADEMY OF SCIENCE COMMITTEE ON PREMEDICAL EDUCATION. A study and analysis of faculty and student opinions of training in preparation for the study of medicine. *J. A. Am. M. Coll.*, 20: 226-236, 1945.

REIMANN, STANLEY P. Public education in cancer. *Clinics*, 4: 6-12, 1945.

U. S. OFFICE OF EDUCATION. Education Under Enemy Occupation in Belgium, China, Czechoslovakia, France, Greece, Luxembourg, Netherlands, Norway, Poland. *Bulletin 1945 No. 3. Washington, D. C.* (U. S. Govt. Printing Office), 1945. Pp. 71. 9⅛ × 5⅞ inches. 15 cents (paper).

U. S. OFFICE OF EDUCATION. Social Leadership. Essentials of Conference Discussion Techniques of Special Value in Supervisory Training Programs in Connection with War Production Training. *Vocational Division Bull. No. 231. Defense Training Series No. 4. Washington, D. C.* (U. S. Govt. Printing Office), 1945. Pp. 43. 9⅛ × 5⅞ inches. 10 cents (paper).

U. S. OFFICE OF EDUCATION. Training School Bus Drivers. *Vocational Division Bulletin No. 233. Trade and Industrial Series No. 61. Washington.* (U. S. Govt. Printing Office), 1945. Pp. x + 162. 9⅛ × 5⅞ inches. 30 cents (paper).

VANCE, EARL L. Platitude for peace planners. *Am. A. Univ. Professors Bull.*, 30: 315-330, 1944.

8. *Ethnology, Cultural Anthropology, Travel and Exploration*

PAUCKE, FLORIÁN. Hacia Allá y Para Acá. (Una Estada Entre los Indios Mocobíes, 1749-1767). Tomo III. Primera parte. *Tucumán-Buenos Aires* (Universidad Nacional de Tucumán), 1944. Pp. xviii + 150 + 16 plates. 10⅞ × 7⅜ inches.

PAUCKE, FLORIÁN. Hacia Allá y Para Acá (Una Estada Entre los Indios Mocobíes, 1749-1767). Tomo III. Segunad parte. *Tucumán-Buenos Aires*, (Universidad Nacional de Tucumán), 1944. Pp. 445 + 71 plates. 10⅞ × 7⅜ inches.

IV. SOMATOLOGY AND CONSTITUTION

1. *Anatomy*

HORTEGA, PÍO DEL RÍO. Microglia. *Lancet*, 1: 102, 1939.

HORTEGA, PÍO DEL RÍO, M. POLAK and J. M. PRADO. Estudios sobre la neuroglía

periférica; la neuroglía de los ganglios sensitivos. *Rev. Soc. argent. de biol.*, 18: 159, 1942.

HORTEGA, Pío DEL Río and J. M. PRADO. Estudios sobre la neuroglía periférica; la neuroglía de los ganglios simpáticos. *Rev. Soc. argent. de biol.*, 17: 512,1941.

SHANKLIN, WILLIAM M. Histogenesis of pituicytes in the chick. *J. Anat.*, 78 (part 3): 79-93, 1944. [Bibliography of 32 titles.]

SHANKLIN, WILLIAM M. Histogenesis of the pig neurohypophysis. *Am. J. Anat.*, 74: 327-353, 1944. [Bibliography of 27 titles.]

2. *Physical Anthropology and Anthropometry*

AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS. Proceedings of the Fourteenth Annual Meeting: The Wistar Institute of Anatomy and Biology, Philadelphia, Pa., March 24 and 25. *Am. J. Phys. Anthropol.*, 3 (n. s.): 215-227, 1945.

DAVENPORT, CHARLES BENEDICT. Postnatal development of the human extremities. *Proc. Am. Philosophical Soc.*, 88: 375-455, 1944. [Bibliography of 137 titles.]

DUPERTUIS, C. WESLEY. The size and proportions of adult midgets. *Am. J. Phys. Anthropol.*, 3 (n. s.): 111-126 + 1 plate, 1945. [1 reference.]

LASKER, GABRIEL W. Observations on the teeth of Chinese born and reared in China and America. *Am. J. Phys. Anthropol.*, 3 (n. s.): 129-150, 1945. [Bibliography of 63 titles.]

OETTEKING, BRUNO. Skeletal remains from Prince William Sound, Alaska. (Cont'd). *Am. J. Phys. Anthropol.*, 3 (n. s.): 177-204 + 1 plate, 1945. [12 bibliographic footnotes.]

PALMER, CARROLL E. Studies of the center of gravity in the human body. *Child Development*, 15: 99-180, 1945. [Bibliography of 59 titles.]

3. *Constitution*

[Vacant]

V. PHYSIOLOGY AND BIOCHEMISTRY

1. *Physiology*

ADAMSON, J. D., *et al.* Medical survey of nutrition in Newfoundland. *Canad. M. A. J.*, 52: 227-250 + 4 plates, 1945. [Bibliography of 42 titles.]

MANN, FRANK C. Hypoglycemia and restoration with glucose. *J. A. M. A.*, 126: 467-469, 1944.

RONCHESE, FRANCESCO. Calluses, cicatrices and other stigmas as an aid to personal identification. *J. A. M. A.*, 128: 925-932, 1945. [9 bibliographic footnotes.]

ROTH, GRACE M., JOHN B. MCDONALD, and CHARLES SHEARD. The effect of smoking cigarets. *J. A. M. A.*, 125: 761-767, 1944. [27 bibliographic footnotes.]

SUÑER, JAIME PI. Las Bases Fisiológicas de la Alimentación. *Mexico* (La Casa de España), 1940. Pp. 208.

2. *Senescence, Senility and Longevity*

MAHLIE, W. S. Good water and human longevity. *Scient. Monthly.*, 60: 455-458, 1945.

SUMNER, FRANCIS B. A biologist reflects upon old age and death. *Scient. Monthly*, 61: 143-149, 1945.

3. *Biochemistry*

BOUDREAU, FRANK G. The problems we face in nutrition. *Scient. Monthly*, 60: 443-450, 1945. [Bibliography of 11 titles.]

CALLAWAY, J. LAMAR, D. F. MILAM, and RAY O. NOOJIN. Nutritional survey of three hundred and fifty-four dermatologic patients. *Arch. Dermat. and Syph.*, 51: 266-269, 1945. [4 bibliographic footnotes.]

CRAVIOTO B., RENÉ, *et al.* Composition of typical Mexican foods. *J. Nutrition*, 29: 317-329, 1945. [Bibliography of 17 titles.]

GIRAL, JOSÉ. Fermentos. *Mexico* (La Casa de España), 1940. Pp. 239.

GIRAL, JOSÉ. Significación bioquimica del agua y sus componentes. *Rev. Soc. mexicana de Historia Natural*, 4: 1, 1943.

MADINAVEITIA, JUAN. Studies on diffusing factors. V. Separation of the diffusing factor from the proteolytic enzymes present in culture filtrate of *Clostridium welchii*. *Biochem. J.*, 34: 621, 1940.

MEDICAL RESEARCH COUNCIL. COMMITTEE ON HAEMOGLOBIN SURVEYS. Haemoglobin Levels in Great Britain in 1943. (With Observations upon Serum Protein Levels.) *London* (H. M. Stationery Office), 1945. *Special Report Series No. 252.* Pp. vi + 128 + 1 chart. 9⅝ × 6 inches. 2*s.* [References at end of each chapter.]

TOENNIES, GERRIT. Chemistry and cancer. *Clinics*, 4: 102-111, 1945. [2 references.]

4. *Pharmacology*

BUCHIN, IRVING. Drugs in treatment of periodontal disease. *Bull. U. S. Army M. Dept.*, 4: 209-214, 1945. [8 bibliographic footnotes.]

BUNTING, JOHN J. and NORMAN E. LEVAN. Toxic reactions of sulfa-guanidine therapy. *J. A. M. A.*, 125: 773-774, 1944.

BUTT, HUGH R., *et al.* Studies in rheumatic fever. I. The physiologic effect of sodium salicylate on the human being, with particular reference to the prothrombin level of the blood and the effect on hepatic parenchyma. *J. A. M. A.*, 128: 1195-1200, 1945. [13 bibliographic footnotes.]

CIRERA, RAMÓN PÉREZ. Estudio comparativo entre la *Digitalis purpurea* y la *Digitalis lanata*. *Arch. Latino-Americanos de Cardiologia y Hematologia*, 12: 171, 1942.

EATON, MONROE D. and V. LEE HANFORD. Effect of the host in action of sulfonamides on elementary-body agents of murine and feline pneumonitis. *Proc. Soc. Exper. Biol. and Med.*, 59: 63-66, 1945. [12 bibliographic footnotes.]

EDDY, JAMES H. Carbon tetrachloride poisoning. A preliminary report on the use of methionine in hepatitis. *J. A. M. A.*, 128: 994-996, 1945. [9 bibliographic footnotes.]

FAULTY, G. B., T. L. DUGGAN, R. T. STORMONT, and C. C. PFEIFFER. The use of penicillin in the treatment of peritonitis. *J. A. M. A.*, 126: 1132-1134, 1944. [4 bibliographic footnotes.]

FISHBERG, ELLA H. and JEFFERSON VORZIMER. Extrathyroid effects of thiouracil therapy. *J. A. M. A.*, 128:915-921, 1945. [1 bibliographic footnote.]

GYÖRGY, PAUL, H. N. VANDEGRIFT, WILLIAM ELIAS, L. G. COLIO, F. M. BARRY, and J. D. PILCHER. Administration of penicillin by mouth. *J. A. M. A.*, 127: 639-642, 1945. [11 bibliographic footnotes.]

HARDY, ALBERT V. Studies of the acute diarrheal diseases. XC. Further cultural observations on the relative efficacy of sulfonamides in *Shigella* infections. *Pub. Health Rep.*, 60: 1037-1042, 1945. [1 reference.]

MCCLOSKY, WILLIAM T. and M. I. SMITH. Studies on the pharmacologic action and the pathology of alphanaphthyothiourea (ANTU). *Pub. Health Rep.*, 60: 1101-1113, 1945. [Bibliography of 7 titles.]

MELENEY, FRANK L. A statistical analysis of a study of the prevention of infection in soft part wounds, compound fractures, and burns with special reference to the sulfonamides. *Surg., Gynec., and Obst.*, 80: 263-296, 1945.

MENDEZ, RAFAEL and A. RAVIN. On the action of prostigmine on the circulatory system. *J. Pharmacol. and Exper. Therap.*, 72: 80, 1941.

SMITH, M. I. and W. T. MCCLOSKY. The chemotherapeutic action of streptomycin and promin in experimental tuberculosis. *Pub. Health Rep.*, 60: 1129-1138, 1945. [Bibliography of 16 titles.]

THOMPSON, PAUL E. The effects of sulfonamide diets upon infections of *Plasmodium elongatum* in canaries. *J. Infect. Dis.*, 76: 15-19, 1945. [Bibliography of 6 titles.]

YEOMANS, ANDREW, J. C. SNYDER, E. S. MURRAY, C. J. D. ZARAFONETIS, and R. S. ECKE. The therapeutic effect of para-aminobenzoic acid in louse-borne typhus fever. *J. A. M. A.*, 126: 349-356, 1944. [15 bibliographic footnotes.]

VI. PATHOLOGY, CLINICAL MEDICINE AND SURGERY

BARKER, M. HERBERT, RICHARD B. CAPPS, and FRANK W. ALLEN. Acute infectious hepatitis in the Mediterranean theater. *J. A. M. A.*, 128: 997-1003, 1945. [15 bibliographic footnotes.]

BLAKE, FRANCIS G., KENNETH F. MAXCY, JOSEPH F. SADUSK, JR., GLEN M. KOHLS, and E. JOHN BELL. Studies on tsutsugamushi disease (scrub typhus, mite-borne typhus) in New Guinea and adjacent islands: epidemiology, clinical observations, and etiology in the Dobadura area. *Am. J. Hyg.*, 41: 243-373 + 3 plates, 1945. [Bibliography of 152 titles.]

BONILLA NAAR, ALFONSO. Life cycle chart of *E. hystolitica*. *Rev. Fac. de med., Bogota*, 13: no. 2, 1944. Pp. (of reprint) 2.

BONILLA NAAR, ALFONSO. Life cycle charts of: Malaria parasites; *Trypanosoma cruzi*; *Balantidium coli*; Trematode. *Rev. Fac. de med., Bogota*, 13: no. 9, 1945. Pp. (of reprint) 4.

BONILLA NAAR, ALFONSO. Life cycle charts of *Strongyloides stercoralis*, *Ancylostoma duodenale*, and *Necator americanus*. *Rev. Fac. de med., Bogota*, 13: no. 3, 1944. Pp. (of reprint) 4.

BONILLA NAAR, ALFONSO. Life cycle charts of *Taenia saginata* and *solium*. *Rev. Fac. de med., Bogota*, 13: no. 4, 1944. Pp. (of reprint) 4.

BONILLA NAAR, ALFONSO. Life cycle charts of *Trichenella spiralis, Trichocephalus trichiurus, Ascaris lumbricoides,* and *Enterobius vermicularis,* and tropical diseases vs. man. *Rev. Fac. de med., Bogota*, 13: no. 8, 1945. Pp. (of reprint) 5.

BORDEN, DANIEL L., JAMES F. WADDILL and GEORGE S. GRIER, III. Statistical study of 265 cases of heat disease. *J. A. M. A.*, 128: 1200-1205, 1945. [13 bibliographic footnotes.]

BOWMAN, J. CRAIG. The role of the general practitioner. *J. A. M. A.*, 126: 331-333, 1944.

BRIGGS, ROBERT. Embryology and cancer. *Clinics*, 4: 112-117, 1945. [Bibliography of 7 titles.]

BUSQUETS, SALVADOR C., JR. Cyst of the pancreas. *Bol. Asoc. med. de Puerto Rico*, 37: 119-132, 1945. [Bibliography of 16 titles.]

COMPTON, B. C., R. E. BIEREN, E. G. JONES, B. H. INLOES, JR., THEODORE KARDASH, and J. M. HUNDLEY, JR. Treatment of gonococcic vulvovaginitis. *J. A. M. A.*, 127: 6-9, 1945. [8 bibliographic footnotes.]

FILATOV, V. P. Tissue therapy in cutaneous leishmaniasis. *Am. Rev. Soviet Med.*, 2: 484-490 + 2 plates, 1945. [Bibliography of 5 titles.]

FROBISHER, MARTIN, JR., MARTHA L. ADAMS, and WILLIAM J. KUHNS. Characteristics of diphtheria bacilli found in Baltimore since November, 1942. *Proc. Soc. Exper. Biol. and Med.*, 58: 330-334, 1945. [7 bibliographic footnotes.]

GILLMAN, THEODORE and JOSEPH GILLMAN. Hepatic damage in infantile pellagra. *J. A. M. A.*, 129: 12-19, 1945. [37 bibliographic footnotes.]

GOVER, MARY and JESSE B. YAUKEY. Physical impairments of members of low-income farm families—11,490 persons in 2,477 farm security administration borrower families, 1940. V. Defects of the nasal septum; and chronic respiratory affections, exclusive of diseased tonsils. *Pub. Health Rep.*, 60: 1069-1085, 1945. [Bibliography of 11 titles.]

GROW, JOHN B., OMER M. RAINES, and ORA L. HUDDLESTON. Reconditioning in chest surgery. *J. A. M. A.*, 126: 1059-1060, 1944.

HAMMON, W. MCD., W. C. REEVES, S. R. BENNER, and BERNARD BROOKMAN. Human encephalitis in the Yakima Valley, Washington, 1942. *J. A. M. A.*, 128: 1133-1139, 1945. [18 bibliographic footnotes.]

HELLER, CARL G. and GORDON B. MYERS. The male climacteric, its symptomatology, diagnosis and treatment. *J. A. M. A.*, 126: 472-477, 1944. [13 bibliographic footnotes.]

HERBER, E. C. Life history studies on two trematodes of the subfamily Notocotylinae. *J. Parasitol.*, 28: 179-196, 1942. [Bibliography of 19 titles.]

HINGSON, ROBERT A. Continuous caudal analgesia. *J. A. M. A.*, 126: 1129-1131, 1944.

KUNSTADTER, RALPH H. and ROBERT C. PENDERGRASS. Primary coccidioidomycosis. A possible pediatric problem. *J. A. M. A.*, 127: 624-627, 1945. [13 bibliographic footnotes.]

LANE, C. GUY, ETHEL M. ROCKWOOD, CARL S. SAWYER, and IRVIN H. BLANK. Dermatoses of the hands. *J. A. M. A.*, 128: 987-993, 1945. [21 bibliographic footnotes.]

LARSH, JOHN E., JR. Comparative studies on a mouse strain of *Hymenolepis nana* var. *fraterna*, in different species and varieties of mice. *J. Parasitol.*, 30: 21-25, 1944. [Bibliography of 6 titles.]

LARSH, JOHN E., JR. Comparing the percentage development of the dwarf tapeworm, *Hymenolepis nana* var. *fraterna*, obtained from mice of two different localities. *J. Parasitol.*, 29: 423-424, 1943.

LARSH, JOHN E., JR. Increased infectivity of the eggs of the dwarf tapeworm *(Hymenolepis nana* var. *fraterna)* following storage in host feces. *J. Parasitol.*, 29: 417-418, 1943. [Bibliography of 4 titles.]

LARSH, JOHN E., JR. Serological studies on the mouse strain of the dwarf tapeworm, *Hymenolepis nana* var. *fraterna*. *Am. J. Hyg.*, 37: 289-293, 1943. [Bibliography of 6 titles.]

LARSH, JOHN E., JR. Studies on the artificial immunization of mice against infection with the dwarf tapeworm *Hymenolepis nana* var. *fraterna*. *Am. J. Hyg.*, 39: 129-132, 1944. [Bibliography of 6 titles.]

LARSH, JOHN E., JR. The relation between splenectomy and the resistance of old mice to infection with *Hymenolepis nana* var. *fraterna*. *Am. J. Hyg.*, 39: 133-137, 1944. [Bibliography of 5 titles.]

LARSH, JOHN E., JR. The relationship between the intestinal size of young mice and their susceptibility to infection with the cestode, *Hymenolepis nana* var. *fraterna*. *J. Parasitol.*, 29: 61-64, 1943. [Bibliography of 9 titles.]

LARSH, JOHN E., JR. Transmission from mother to offspring of immunity against the mouse cestode, *Hymenolepis nana* var. *fraterna*. *Am. J. Hyg.*, 36: 187-194, 1942. [Bibliography of 7 titles.]

LARSH, JOHN E., JR. and ALAN W. DONALDSON. The effect of concurrent infection with *Nippostrongylus* on the development of *Hymenolepis* in mice. *J. Parasitol.*, 30: 18-20, 1944. [Bibliography of 3 titles.]

LEVY, ROBERT L., PAUL D. WHITE, WILLIAM D. STROUD and CHARLES C. HILLMAN. Transient hypertension. The relative prognostic importance of various systolic and diastolic levels. *J. A. M. A.*, 128: 1059-1061, 1945. [5 bibliographic footnotes.]

MEIKLEJOHN, GORDON, MONROE D. EATON, and WILLIAM VAN HERICK. A clinical report on cases of primary atypical pneumonia caused by new virus. *J. Clin. Investigation*, 24: 241-250, 1945. [Bibliography of 19 titles.]

NEGOVSKI, V. A. Agonal states and clinical death: problems in revival of organism. Chapter IV. The electrocardiogram during death and revival. *Am. Rev. Soviet Med.*, 2: 491-499, 1945.

PAUL, JOHN R., W. P. HAVENS, JR., A. B. SABIN and C. B. PHILIP. Transmission experiments in serum jaundice and infectious hepatitis. *J. A. M. A.*, 128: 911-915, 1945. [40 bibliographic footnotes.]

REISNER, DAVID and JEAN DOWNES. Minimal tuberculous lesions of the lung. *Am. Rev. Tuberculosis*, 51: 393-412, 1945. [Bibliography of 7 titles.]

RIENHOFF, WILLIAM FRANCIS, JR. The present status of the surgical treatment of primary carcinoma of the lung. *J. A. M. A.*, 126: 1123-1128, 1944. [4 bibliographic footnotes.]

ROOT, HOWARD F. The use of insulin and the abuse of glucose in the treatment of diabetic coma. *J. A. M. A.*, 127: 557-564, 1945. [19 bibliographic footnotes.]

RUTSTEIN, DAVID D. The role of the cardiac clinic in the rheumatic program. *J. A. M. A.*, 126: 484-486, 1944. [9 bibliographic footnotes.]

SALK, JONAS E., WILBUR J. MENKE, JR., and THOMAS FRANCIS, JR. A clinical, epidemiological and immunological evaluation of vaccination against epidemic influenza. *Am. J. Hyg.*, 42: 57-93, 1945. [Bibliography of 49 titles.]

SENSENBACH, WILLIS. Bromide intoxication. *J. A. M. A.*, 125: 769-772, 1944. [8 bibliographic footnotes.]

SILBERT, SAMUEL. Etiology of thromboangiitis obliterans. *J. A. M. A.*, 129: 5-9, 1945. [9 bibliographic footnotes.]

TEAGUE, RUSSELL E. The common intestinal parasites in Kentucky. *Bull. Dept. Health of Kentucky*, 17: 431-439, 1945. [Bibliography of 8 titles.]

TELINDE, RICHARD W. The surgical treatment of prolapse of the uterus. *J. A. M. A.*, 127: 495-502, 1945.

VON OETTINGEN, W. F. Carbon Monoxide: Its Hazards and the Mechanism of its Action. *Washington, D. C.* (U. S. Govt. Printing Office), 1944. *U. S. Public Health Bulletin No. 290.* Pp. vi + 257. 9⅛ × 5⅞ inches. 35 cents (paper). [Bibliography of 47 pages.]

WATT, JAMES. An outbreak of *Salmonella* infection in man from infected chicken eggs. *Pub. Health Rep.*, 60: 835-839, 1945. [Bibliography of 5 titles.]

YATER, WALLACE M. Diagnosis of liver abscess by means of thorotrast hepatosplenography. *J. A. M. A.*, 125: 775-778, 1944. [5 bibliographic footnotes.]

YOEMANS, ANDREW, J. C. SNYDER and A. G. GILLIAM. The effects of concentrated hyperimmune rabbit serum in louse borne typhus. *J. A. M. A.*, 129: 19-24, 1945. [20 bibliographic footnotes.]

ZELIGS, MEYER A. Psychosomatic aspects of filariasis. *J. A. M. A.*, 128: 1139-1144, 1945. [4 bibliographic footnotes.]

VII. METHODOLOGY

1. *Mensurational and Observational*

MALMO, R. B. and L. R. CRISP. A new reaction time apparatus and a new method of administering the reaction time test. *Pub. Health Rep.*, 60: 947-958 + 1 plate, 1945. [Bibliography of 7 titles.]

SCHNEITER, ROY, JOHN E. DUNN, and BARBARA H. CAMINITA. Studies in connection with the selection of a satisfactory culture medium for bacterial air sampling. *Pub. Health Rep.*, 60: 789-806 + 1 plate, 1945. [Bibliography of 36 titles.]

2. *Mathematical and Statistical*

BUREAU OF THE CENSUS. *Vital statistics — Special Reports. Washington, D. C.* Various numbers of Volume 23, selected studies as follows:

4. A new pattern in registration concepts. July 3, 1945. Pp. 81-86.

5. Demographic responsibilities of a registration office as developed in Baltimore, Maryland. July 3, 1945. Pp. 87-96.

SANTALO, LUIS A. Sobre las probabilidades continuas. *Ciencia*, 1: p. 343, 1940.

3. *Other and General*

EATON, MONROE D., MARILLA COREY, W. VAN HERICK and GORDON MEIKLEJOHN. A comparisan of various methods of demonstrating influenza virus in throat washings. *Proc. Soc. Exper. Biol. and Med.*, 58: 6-9, 1945. [9 bibliographic footnotes.]

MEDES, GRACE. Isotopes in the study of cancer. *Clinics*, 4: 128-134, 1945.

MEDICAL RESEARCH COUNCIL. The Sterilization, Use and Care of Syringes. *London* (H. M. Stationery Office), 1945. *War Memorandum No.* 15. Pp. 23. 9⅜ × 6 inches. 4d. [Bibliography of 44 titles.]

MILLER, NORMAN F. An interpretation and evaluation of tubal patency tests. *J. A. M. A.*, 129: 243-246, 1945. [18 bibliographic footnotes.]

VIII. GENERAL AND MISCELLANEOUS

BUSH, VANNEVAR. Science, the Endless Frontier. A Report to the President. *Washington, D. C.* (U. S. Govt. Printing Office), 1945. Pp. ix + 184. 9 × 5¾ inches.

MARYLAND STATE PLANNING COMMISSION AND THE DEPARTMENT OF BUDGET AND PROCUREMENT. [Prepared by Thomas F. Hubbard]. Six-Year Capital Improvement Program for Maryland. Revised 1945. *Baltimore* (Maryland State Planning Commission), 1945. Pp: x + 180. 10¾ × 8½ inches. 25 cents.

ROCKEFELLER FOUNDATION. Annual Report for 1944. *New York* (Rockefeller Foundation), 1944. Pp. xv + 344 + 9 plates. 8½ × 5¾ inches.

U. S. PUBLIC HEALTH SERVICE. FEDERAL SECURITY AGENCY. Manual for Coding Causes of Illness according to a Diagnosis Code for Tabulating Morbidity Statistics. *Washington, D. C.* (U. S. Govt. Printing Office), 1944. *Miscellaneous Publication No.* 32. Pp. ii + 489. 9¼ × 6 inches.

VENEZUELA. DIRECCION GENERAL DE ESTADISTICA. Segun el VII Censo National de Poblacion. Nomenclador General de Areas y Lugares Habitados de Venezula. *Caracas, Venezuela*, 1944. Pp. x + 766. 12½ × 9⅜ inches.

INDEX

Age, of mother, stillbirth rates by, 73, 95
of physiologic events, 147
Anatomy (Recent Literature), 56, 159, 255, 390
Asymmetry, and metopism, 131
Atkinson, William B., 137

Behavior (Recent Literature), 52, 156, 251, 387
Bernstein's theory, 13
Biochemistry (Recent Literature), 57, 160, 257, 392
Birth Control (Recent Literature), 250
Birth order, stillbirth rates by, 73, 95
Births, birth rates, Puerto Rico, 278
Blood factor, Rh blood factor inheritance, 195
Blood group inheritance, 13

Calabresi, Massimo, The Relation of Country of Origin to Mortality for Various Causes in New York State, 340-367
Cancer mortality, 351
Chronology of physiologic events, 147
Constitution (Recent Literature), 255
Contribution to the analysis of the exceptions to Bernstein's theory, 13
Country of origin and mortality, 340

Deaths, death rates, Puerto Rico, 278
Diabetes mortality, 350
Diederich, Gertrude Wylie, 195
Dupertuis, C. W., Atkinson, William B., and Elftman, Herbert, Sex Differences in Pubic Hair Distribution, 137-142

Economics (Recent Literature), 54, 158, 253, 388
Education (Recent Literature), 55, 159, 254, 390
Elftman, Herbert, 137
Environment of Man (Recent Literature), 47, 152, 244, 383
Environmental trends among the American Negro, 207
Ethnology, Cultural Anthropology, Travel and Exploration (Recent Literature), 55, 159, 255, 390
Eugenics (Recent Literature), 244
Evolution and Genetics (Recent Literature), 46, 151, 243, 382
Evolution as a maximal principle, 167
Evolution — General Principles (Recent Literature), 46, 151, 243

General and Miscellaneous (Recent Literature), 62, 164, 266, 397
Genetics — General Principles (Recent Literature), 47, 151, 243, 382
Genetics of Rh blood factor, 195

Gestation period, whites and Negroes, 229
Graphic exposition, in biological and medical literature, 314
Group Biology (Recent Literature), 47, 152, 244, 383

Hairiness of thigh and chest, 141
Head measurements, individuals with metopism, 114
Heart disease mortality, 348
Heredity, influence in causation of disease, 362
Hess, Leo, The Metopic Suture and the Metopic Syndrome, 107-136
Hiatus canalis sacralis in American whites and Negroes, 368
History and Biography (Recent Literature), 53, 157, 252, 388
Human Evolution (Recent Literature), 46, 243
Human Heredity (Recent Literature), 47, 244, 382

Iconometrography in graphic exposition, 314
Increase in stature, 233
Individual Psychology (Recent Literature), 52, 156, 251, 387
Inheritance, blood group, 13
    Rh blood factor, 195
Interval between successive births and its effect on survival of infant, 65

Janer, José L., Population Growth in Puerto Rico and Its Relation to Time Changes in Vital Statistics, 267-313

Lanier, Patricia F., 368
Law of evolution as a maximal principle, 167
Life tables, Puerto Rico, 282
Logistic curves describing population growth, Puerto Rico, 271
Longevity of Negro, 224
Lotka, Alfred J., The Law of Evolution as a Maximal Principle, 167-194

Marriage and Divorce (Recent Literature), 52, 156, 251, 387
Martin, W. S., Social Class Mortality, 1-12
Mean age of physiologic events, 147
Methodology (Recent Literature), 61, 163, 265, 396
Metopic suture and the metopic syndrome, 107
Michelson, Nicholas, Studies in the Physical Development. V. The Ossification Time of the Os Pisiforme, 143-146
    VI. The Chronology of Physiologic Events, 147-150
    VII. Environmental Trends among the American Negro, 207-228
    VIII. Résumé and Goals for Further Research, 229-242
Microcephaly, 130
Migration (Recent Literature), 384
Migration, Puerto Rico, 279
Morbidity and Epidemiology (Recent Literature), 50, 155, 249, 385

Mortality and General Vital Statistics (Recent Literature), 50, 154, 247, 385
Mortality, by country of origin, 340
all causes, 345
cancer, 351
diabetes, 350
heart disease, 348
nephritis, 349
pneumonia, 354
social class, 1
trends among Negroes, 216
tuberculosis, 353
MYSLIVEC, VÁCLAV, Contribution to the Analysis of the Exceptions to Bernstein's Theory, 14-45

Natality, Fecundity, Fertility (Recent Literature), 51, 250, 387
Nationality and mortality, 340
Negro environmental trends, 207
Nephritis mortality, 349

Ossification time of the os pisiforme, 143

PATHOLOGY, CLINICAL MEDICINE AND SURGERY (Recent Literature), 58, 161, 259, 393
Pharmacology (Recent Literature), 58, 161, 257, 392
Physical Anthropology and Anthropometry (Recent Literature), 56, 160, 255, 391
Physical development, studies in, 143, 147, 207, 229
Physiologic events chronology, 147
Physiology (Recent Literature), 56, 160, 256, 391
PHYSIOLOGY AND BIOCHEMISTAY (Recent Literature), 56, 160, 256, 391
Pisiform, appearance of, 143
Pneumonia mortality, 354
Population (Recent Literature), 49, 153, 247, 384
Population, by social class, 3
growth in Puerto Rico and its relation to time changes in vital statistics, 267
Prehistory and Archaeology (Recent Literature), 46, 151, 243, 382
Psychiatry (Recent Literature), 53, 157, 252, 388
Pubic hair distribution, 137
Public Health and Hygiene (Recent Literature), 48, 152, 245, 383
Puerto Rico, life tables, 282
population growth, 267

Racial and Genetic Psychology (Recent Literature), 52, 156, 387
Racial differences in extent of hiatus canalis sacralis, 368
RECENT LITERATURE, 46-63, 151-165, 243-266, 382-397
Relation of country of origin to mortality for various causes in New York State, 340
Reproduction rate, net, 191
Rh blood factor among twins, 195

Scammon, Richard E., 314
Senescence, Senility and Longevity (Recent Literature), 257, 392
Senile decay, 236
Sex differences in pubic hair distribution, 137
Sex differentials in mortality, Puerto Rico, 286
Social class mortality, 1
Sociology, Law, Politics and Religion (Recent Literature), 54, 157, 252, 388
SOMATOLOGY AND CONSTITUTION (Recent Literature), 56, 159, 255, 390
Stature, average, and annual increment, 233
Stillbirth rates, by age of mother and order of birth, 73, 95
  effect of interval between births on, 71
STRANDSKOV, HERLUF H., and DIEDERICH, GERTRUDE WYLIE, The Rh Blood Factor among Twins, 195-206
Studies in the physical development, 143, 147, 207, 229
Survivorship curves, Puerto Rico and United States, 285
Syndactylia, 133
Syphilis, among Negroes, 217

Topography of the human body, 314
TROTTER, MILDRED, and LANIER, PATRICIA F., Hiatus Canalis Sacralis in American Whites and Negroes, 368-381
Tuberculosis, among Negroes, 219
  mortality, 353
Twins, Rh blood factor among, 195

Use of iconometrography in graphic exposition, 314

Variability, determined by iconometrographic method, 325
  of physiologic events, 147

WILMER, HARRY A., and SCAMMON, RICHARD E., The Use of Iconometrography in Graphic exposition. I. Topography and Composition of the Human Body, 314-339

YERUSHALMY, J., On the Interval between Successive Births and Its Effect on Survival of Infant. I. An Indirect Method of Study, 65-106

dical Library

MAR 1 8 1946

HUMAN BIOLOGY

a record of research

DECEMBER, 1945

Vol. 17 No 4

PUBLISHED QUARTERLY BY
THE JOHNS HOPKINS PRESS, BALTIMORE, MARYLAND, U.S.A.

HUMAN BIOLOGY

a record of research

FOUNDED BY RAYMOND PEARL

Edited by

LOWELL J. REED

in association with

A. W. FREEMAN H. S. JENNINGS ADOLF MEYER
CURT P. RICHTER ADOLPH H. SCHULTZ

Managing Editor

FRANCES D. NICOLLS

ADVISORY BOARD

ED. CLAPARÈDE
University of Geneva

S. R. DETWILER
Columbia University

EUGEN FISCHER
Kaiser Wilhelm Institut für Anthropologie, Berlin-Dahlem

CORRADO GINI
R. Université de Roma

MAJOR GREENWOOD
School of Hygiene and Tropical Medicine, London

SHINKISHI HATAI
Tôhoku Imperial University, Sendai

ERNST KRETSCHMER
Universitäts-Nervenklinik, Marburg

A. J. LOTKA
Metropolitan Life Insurance Company

H. LUNDBORG
Statens Institut för Rasbiologi, Uppsala

D. PEYRONY
Musée Préhistorique, Les Eyzies (Dordogne)

P. RIVET
Universidad de Bogotá, Colombia

JOHN B. WATSON
New York

CLARK WISSLER
American Museum of Natural History

HUMAN BIOLOGY is published quarterly by The Johns Hopkins Press, Baltimore, Maryland, U. S. A. The advance subscription price is $5.00 a year (foreign postage 35 cents; Canadian 13 cents). Single current issues are $2.00 each; back numbers, $3.00 each; back volumes, $6.00; plus postage. Subscriptions for less than a year are charged at the single issue price.

Subscribers should notify the publishers of change in address at least two weeks before publication of the issue with which change is to take effect. No claim for non-receipt of an issue will be entertained unless made immediately upon receipt of the next succeeding issue.

Manuscripts and communications regarding editorial matters should be addressed to Editor, Human Biology, 615 N. Wolfe St., Baltimore—5, Maryland, U. S. A.

THE JOHNS HOPKINS PRESS, *Publishers*

BALTIMORE—18, MARYLAND, U. S. A.

Entered as Second Class matter, February 18, 1929, at the Post Office at Baltimore, Md., under the Act of March 3, 1879.

Copyright 1946 by The Johns Hopkins Press

Human Biology

a record of research

VOLUME 17 DECEMBER, 1945 NUMBER 4

CONTENTS

POPULATION GROWTH IN PUERTO RICO AND ITS RELATION TO TIME CHANGES IN VITAL STATISTICS. *José L. Janer* 267

THE USE OF ICONOMETROGRAPHY IN GRAPHIC EXPOSITION. I. TOPOGRAPHY AND COMPOSITION OF THE HUMAN BODY. *Harry A. Wilmer and Richard E. Scammon* 314

THE RELATION OF COUNTRY OF ORIGIN TO MORTALITY FOR VARIOUS CAUSES IN NEW YORK STATE. *Massimo Calabresi* 340

HIATUS CANALIS SACRALIS IN AMERICAN WHITES AND NEGROES. *Mildred Trotter and Patricia F. Lanier* 368

RECENT LITERATURE 382

INDEX 390

THE JOHNS HOPKINS PRESS, *Publishers*
BALTIMORE—18, MARYLAND, U. S. A.